UPPER PASSAIC RIVER FLOOD CONTROL
LONG HILL TOWNSHIP, NEW JERSEY
N.Y. DISTRICT, U.S. ARMY CORPS OF ENGINEERS

DETAILED PROJECT REPORT

APPENDIX B – DRAFT GEOTECHNICAL REPORT

GEOTECHNICAL INVESTIGATION REPORT

February 2004

UPPER PASSAIC RIVER
LONG HILL TOWNSHIP
FLOOD CONTROL PROJECT

GEOTECHNICAL INVESTIGATION REPORT

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1. INTRODUCTION

Proposed structural alternatives currently being considered for improvements along Passaic Valley Road include levees, floodwalls, and culvert crossings. This Geotechnical Investigation Report consists of a preliminary evaluation of subsurface conditions as they impact the structural alternatives. The report includes evaluation of existing published data and data collected in the field investigation. The field data consists of test borings, soil sampling, and laboratory testing.

2. EVALUATION OF EXISTING DATA

Geological and geotechnical information for the study site was obtained from geologic and topographic maps and aerial photography. The site is a wooded floodplain near the town of Stirling, NJ in Long Hill Township in southern Morris County near the Somerset County-Warren Township border. It is 15 miles southwest of Newark, NJ and south of the Great Swamp National Wildlife Refuge.

2.2 Physiography and Geomorphology

The study area is nearly flat with approximate elevations ranging from 212 to 215 ft-msl with small hills on the west and east ends that rise above elevation 225 ft-msl. A PSE&G overhead electric transmission line crosses the study area from southwest to northeast. Three drainage ditches flow southward across the study area and into the Passaic River. The Passaic Valley Road parallels the river and is the north boundary of residential and commercial properties that occupy the areas between the road and the River. The levee / floodwall is aligned across two unpaved and one paved road (Warren Avenue).

The project area is located in within the Piedmont physiographic province. This province contains sedimentary and igneous rocks of Jurassic age, including siltstone, shale, sandstone, conglomerate and basalt. The more resistant basalt has formed ridges and uplands. The Watchung Mountains, Long Hill and Hook Mountains, rising to elevations over 400 ft-msl, are comprised of this basalt. The valleys and lowlands are comprised of the sedimentary rocks that are overlain by glacial outwash. A terminal moraine from the Wisconsin glacial period is located to the northeast of the project area. Remnants of glacial outwash have formed level plains sloping from the terminal moraine. This outwash is a combination of sand and gravel deposited from glacial meltwaters and silt and clay deposited by glacial lakes. Such lakes typically form adjacent to the glaciers upon retreat. Glacial Lake Passaic is responsible for the thick deposits of silts and clays, which are found within the project area.

2.3 General Soil Information

The USDA/SCS Soil Survey for Morris County, issued August 1976, shows two soil types within and one soil type adjacent to the project area. Within the project area are the Urban land-Penn complex (Um) and Urban land-Whippany complex (Uw).

The Um soil type is described as being well-drained soils that are underlain by red shale. It occurs near the bottom of slopes of the Watchung Mountains. Um soils consist of approximately 40 percent cut and fill land and 40 percent Penn soils. These types occur in a complex pattern and can not be mapped separately. The underlying red shale was encountered in boring B-1 at a depth of 7 feet.

The Uw soil type is described as somewhat poorly drained, nearly level or gently sloping clayey soils. It occurs in areas where developments extend into the bottom of the basin formerly occupied by glacial Lake Passaic. The soil is about 40 percent fill land and 40 percent Whippany soils in a complex pattern. The complex displays a water table near the surface most of the winter and spring. Occasional flooding is a hazard. In many areas drainage cannot be improved due to the low position of the soil.

Adjacent to the project area is the Parsippany silt loam (Ph). This soil is found adjacent to the Passaic River to the south of the project area. This soil is described as deep, nearly level, and poorly drained and is on the level bottom of the basin formerly occupied by glacial Lake Passaic. Ph soils formed in stratified sediment of lacustrine (lake) origin derived mostly from red and brown shale, basalt and granitic rock. It has a perched water table at or near the surface for long periods. Because of its low position on the landscape, the soil receives runoff from adjoining higher areas.

3. FIELD INVESTIGATION

A Test Drilling Program was performed from October 29th to October 30th, 2002 by Land, Air, Water Environmental Services, Inc. of Center Moriches, NY. Eight (8) test borings were completed, totaling 179 lineal feet (locations on Figure 1). The boring depths varied from 14.0 feet to 25.0 feet. The test borings were inspected by a Geologist from the Michael Baker Corporation and the test boring records can be found in Appendix A. Test borings were advanced by direct push methods using a track-mounted Geoprobe rig with a 1-1/2 inch I.D., 5 foot barrel. Continuous and representative samples of each soil type were collected in a clear plastic liner for further observation and laboratory testing. Pocket penetrometer test were taken and recorded to obtain unconfined compression test values. Groundwater depths, if encountered, were noted on the test boring records. Test borings were backfilled with bentonite and cement upon completion.

No undisturbed samples were taken for this phase of the project. A field representative of the New York District Corps of Engineers was present to take Hnu readings on the soil samples.

TABLE 1 – TEST BORING SUMMARY

Boring No.	Surface Elevation (ft-msl)	Total Depth (ft)	Depth to Ground Water (ft)
B-1	215.0	14.0	10.0
B-2	213.0	25.0	4.5
B-3	212.3	20.0	9.3
B-4	212.3	25.0	5.4
B-5	212.3	25.0	2.1
B-6	212.5	20.0	2.0
B-7	212.5	25.0	Dry
B-8	209.0	25.0	Dry

4. LABORATORY TESTING

Selected samples were tested for moisture content and Atterberg limits (liquid limit, plastic limit, and plasticity index). Ackenheil Engineers, Inc. tested twelve samples under contract to Baker. Test results appear in Table 2 below. Unified Soil Classifications were determined using Atterberg limits alone, since nearly all samples were fine-grained soils. These classifications ranged from MH (elastic silt) to CH (fat clay). Laboratory test data appears in Appendix B.

TABLE 2 - LABORATORY TEST RESULTS

Boring No.	Sample Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Moisture Content (%)	Classification (USCS/ AASHTO)
B-1	5.8-6.3	55	29	26	24.8	CH/A-7-6
B-2	24.6-24.8	60	31	29	43.8	MH/A-7-5
B-4	24.7-25.0	33	24	9	29.7	ML/A-4
B-5	9.4-10.0	33	23	10	25.7	CL/A-4
B-5	19.0-19.4	29	22	7	27.3	CL/A-4
B-6	8.4-8.8	32	22	10	24.8	CL/A-4
B-6	16.0-16.4	32	23	9	27.6	CL/A-4
B-7	7.8-8.2	57	29	28	33.8	CH/A-7-6
B-7	21.2-21.6	58	28	30	39.5	CH/A-7-6
B-8	6.9-7.3	46	27	19	27.9	ML/A-7-6
B-8	12.3-12.8	59	28	31	36.6	CH/A-7-6

TABLE 2 - LABORATORY TEST RESULTS

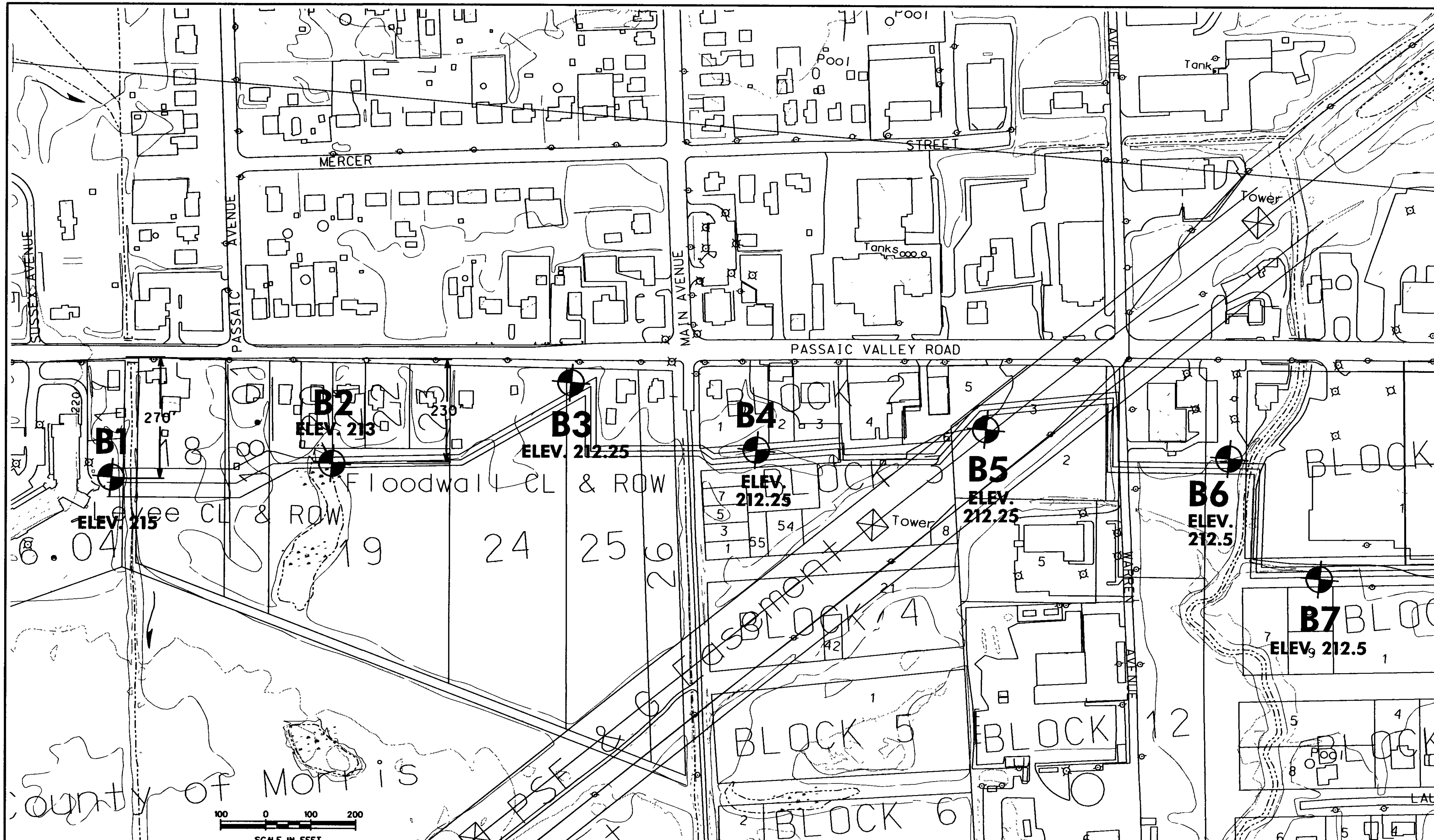
Boring No.	Sample Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Moisture Content (%)	Classification (USCS/ AASHTO)
Parameter Range		*29 to 60*	*22 to 31*	*7 to 31*	*24.8 to 43.8*	

5. SUMMARY OF SUBSURFACE CONDITIONS

Eight (8) test borings were completed along the proposed levee / flood wall alignment. Topsoil was absent in borings B-1, B-6 and B-7 and reached a maximum of 1.0 ft in boring B-4. Boring B-5 encountered 0.5 ft of buried topsoil, classified as Peat, at a depth of 2 feet. Glacio-lacustrine deposits, sediments deposited from glacial Lake Passaic, were encountered in all of the borings and ranged from 7.0 ft thick in boring B-1 to at least 25.0 ft thick (total depth of boring) in borings B-2, B-7 and B-8. The glacio-lacustrine deposits were described as either silt, silty clay or clay. A notable change in color of the glacio-lacustrine deposit occurred between depths of 13.5 feet in B-3 and B-4, and 17.5 feet in B-5. The soil changes from a reddish brown, above, to gray and grayish brown, below. The reddish brown soils ranged from medium stiff to hard, whereas the gray and grayish brown soils ranged from soft to very stiff. The average range of consistency of the soils was stiff to very stiff. Moisture contents varied from moist to wet, with an average condition as moist. Boring B-1 encountered residual soil, derived from shale, at a depth of 7.0 feet. Refusal occurred on shale at 14.0 feet. This boring was the only one to penetrate residual soil.

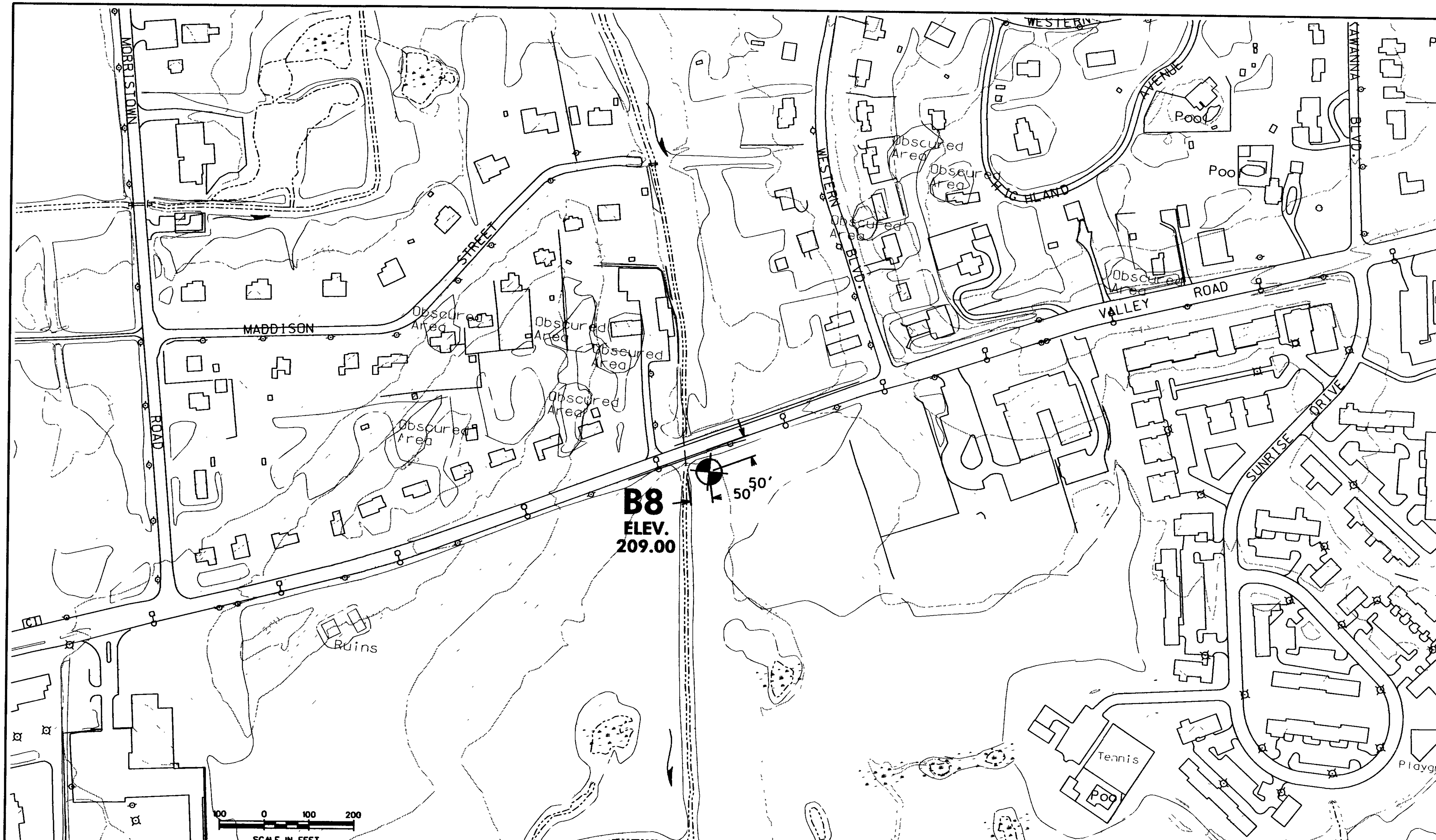
See Figure 2 for a Geologic Section across borings B-1 through B-8. Test boring records are included in Attachment A.

FIGURES



REVISIONS						
	DESIGNED M.M. DRAWN B.C.D. CHECKED REVIEWED S.O. 24421-007-0002-00007 CADD FILE			MICHAEL BAKER JR., INC. CONSULTING ENGINEERS BEAVER, PENNSYLVANIA	PASSAIC RIVER LEVEE WALL BORING PLAN SCALE 1"=100' DATE NOVEMBER, 2002	FIGURE 1 PG. 1 OF 2

$$-----DESIGN-FILE-NAME-----$$ $$-SDATE-$$



REVISIONS

DESIGNED	M.M.
DRAWN	B.G.D.
CHECKED	
REVIEWED	
S.O.	24421-007-0002-00007
CADD FILE	

MICHAEL BAKER JR., INC.

CONSULTING ENGINEERS BEAVER, PENNSYLVANIA

Baker

PASSAIC RIVER
LEVEE WALL
BORING PLAN

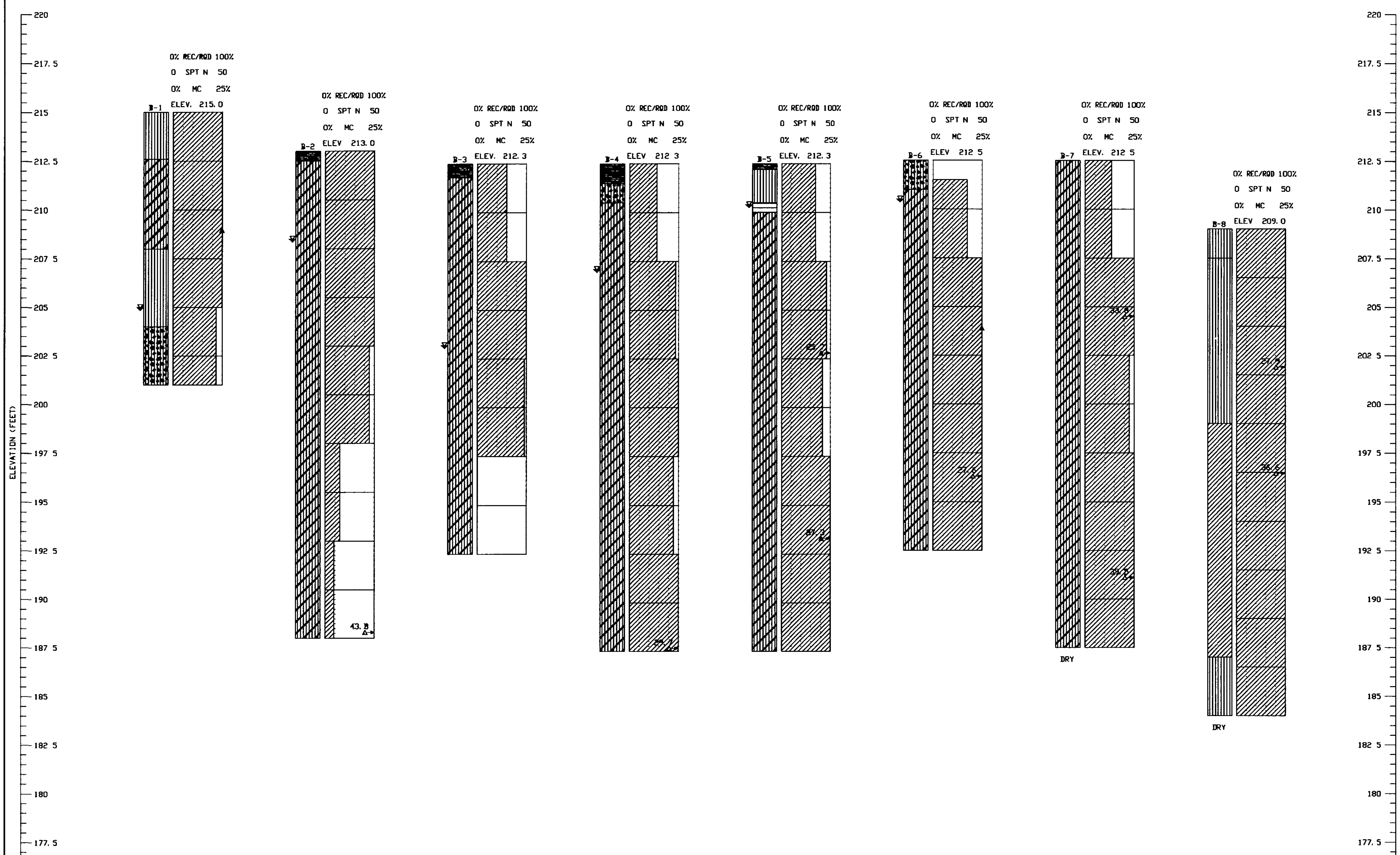
SCALE 1"=100'

DATE NOVEMBER, 2002

FIGURE
1

PG. 2 OF 2

$$-----DESIGN-FILE-NAME-----$$ $$-SDATE-$$



PLAN VIEW (NTS)

KEY

- 0 HR WATER LEVEL
- 24 HR WATER LEVEL
- BORING CAVED DEPTH
- SPT N (BLOWS/FT)
- H_2O CONTENT (%)
- 27.3 H_2O CONTENT EXCEEDS 25%
- RECOVERY (%)
- RQD (%)

STRATA SYMBOLS

- Silt (ML)
- Silty low plasticity clay (CL-ML)
- Silty gravel (GM)
- Topsoil
- Peat
- Low plasticity clay (CL)

NOTES	DESIGNED: DRAWN: LD3(PG_22X34 04/00 CHECKED REVIEWED: S.O.: 24421-007-0002-00007 FILE: passaic	HORIZONTAL SCALE NONE VERTICAL SCALE 0 2.5	Passaic River Flood Wall Project Morris, NJ County MICHAEL BAKER JR., INC CONSULTING ENGINEERS BEAVER, PENNSYLVANIA	Baker	GEOLOGIC CROSS SECTION SCALE: AS SHOWN DATE 11/26/2002	FIGURE 2

$$LABEL$$

ATTACHMENT A
TEST BORING LOGS

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO. B-1
SHEET 1 **OF** 1
DATE: START 10/29/02
END 10/29/02
O.G. ELEV. 215

PROJECT NAME Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION ______ **OFFSET** ______ **BASELINE** ______
COORDINATES: NORTH: ______ **EAST:** ______
INSPECTOR (SIGNED) Mark Martin **DRILLERS NAME/COMPANY** Brian Ramos/Land, Air & Water Env Svs
EQUIPMENT USED Geoprobe 66DT Track Rig
DRILLING METHODS 1-1/2" I D., 5 0' Sampler
CASING: SIZE: ______ **DEPTH:** ______ **WATER: DEPTH:** 10 0 **TIME:** 0 hrs. **DATE:** 10/29/02
CHECKED BY: John Callahan **DATE:** 11/05/02 **DEPTH:** ______ **TIME:** ______ **DATE:** ______
S.O. NUMBER: 24421-007-0002-00007 **FILE:** passaic **NOT ENCOUNTERED** ☐ **INCLINATION (DEGREES):** 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0–5 0	DP-1		5 0	100	1 0-2 5			SILT w/ Gravel, (ml/a-4), brown, gray and red, moist, stiff to very stiff; -PL to NPL, stratified, gravel is subangular, fine to coarse, shale fragments	Glacio-Lacustrine
2.4					3 0-4 5			Silty CLAY; (cl-ml/a-4); reddish brown and gray; dry to moist; very stiff to hard; -PL, blocky	EL 212 6 Glacio-Lacustrine
5 0–10 0	DP-2		5 0	100		CH / A-7-6	24.8		
7 0					1.0-2 0			Gravelly SILT, (ml/a-4), red, moist, stiff, -PL to NPL; homogeneous; gravel is angular, fine to coarse, shale fragments	EL 208.0 Residual shale
10 0–14 0	DP-3		3 5	88				Encountered water at 10 0'	EL 205 0
11.0					NA			Silty GRAVEL, (gm/a-1-b); red, wet to dry; medium dense to very dense, homogeneous; gravel is angular, fine to coarse, shale fragments	EL. 204 0 Residual shale
14 0								Refusal and End of boring at 14 0	EL 201.0

Boring backfilled with bentonite and cement on 10/29/02 No 24 hr water level Classification result based on Atterberg limits only. Elevation based on topographic plan

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO.	B-3
SHEET	2 OF 2
DATE: START	10/30/02
END	10/30/02
O.G. ELEV.	212.3

PROJECT NAME: Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION: OFFSET: BASELINE:
COORDINATES: NORTH: EAST:
INSPECTOR (SIGNED): Mark Martin DRILLERS NAME/COMPANY: Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED: Geoprobe 66DT Track Rig
DRILLING METHODS: 1-1/2" I.D., 5.0' Sampler
CASING: SIZE: DEPTH: WATER: DEPTH: 9.3 TIME: 0 hrs. DATE: 10/30/02
CHECKED BY: John Callahan DATE: 11/05/02 DEPTH: TIME: DATE:
S.O. NUMBER: 24421-007-0002-00007 FILE: passaic NOT ENCOUNTERED ☐ INCLINATION (DEGREES): 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
20.0								End of boring at 20.0 — 20.0	EL. 192.3

Boring backfilled with bentonite and cement on 10/30/02. No 24 hr. water level. Elevation based on topographic plan.

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO.	B-3
SHEET	1 OF 2
DATE: START	10/30/02
END	10/30/02
O.G. ELEV.	212.3

PROJECT NAME: Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION: OFFSET: BASELINE:
COORDINATES: NORTH: EAST:
INSPECTOR (SIGNED): Mark Martin DRILLERS NAME/COMPANY: Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED: Geoprobe 66DT Track Rig
DRILLING METHODS: 1-1/2" I.D., 5.0' Sampler
CASING: SIZE: DEPTH: WATER: DEPTH: 9.3 TIME: 0 hrs. DATE: 10/30/02
CHECKED BY: John Callahan DATE: 11/05/02 DEPTH: TIME: DATE:
S.O. NUMBER: 24421-007-0002-00007 FILE: passaic NOT ENCOUNTERED ☐ INCLINATION (DEGREES): 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0	DP-1		3.0	60	3.0-4.0			TOPSOIL; (ml/a-4); black and dark brown; moist; loose, homogeneous — 0.7	EL. 211.6
								Silty CLAY; (cl-ml/a-4); orange to reddish brown; moist; medium stiff to very stiff; -PL to NPL; laminated	Glacio-Lacustrine
5.0	DP-2		5.0	100	1.0-3.0				
10.0	DP-3		4.8	96	2.5-3.0			0.5' - wet and very soft zone, and encountered water at 12.0'	EL. 200.3
								gray below 13.5'	EL. 198.8
15.0	DP-4		0.0	0				very soft below 15.0'	EL. 197.3 Sample DP-4 would not stay in barrel, 2 attempts to retrieve.

Boring backfilled with bentonite and cement on 10/30/02 No 24 hr. water level. Elevation based on topographic plan.

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO.	B-2
SHEET	2 OF 2
DATE: START	10/30/02
END	10/30/02
O.G. ELEV.	213

PROJECT NAME: Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION: OFFSET: BASELINE:
COORDINATES: NORTH: EAST:
INSPECTOR (SIGNED): Mark Martin DRILLERS NAME/COMPANY: Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED: Geoprobe 66DT Track Rig
DRILLING METHODS: 1-1/2" I.D., 5.0' Sampler
CASING: SIZE: DEPTH: WATER: DEPTH: 4.5 TIME: 0 hrs. DATE: 10/30/02
CHECKED BY: John Callahan DATE: 11/05/02 DEPTH: TIME: DATE:
S.O. NUMBER: 24421-007-0002-00007 FILE: passaic NOT ENCOUNTERED ☐ INCLINATION (DEGREES): 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
20.0	DP-5		0.9	18	2.0	MH / A-7-5	43.8		
25.0								End of boring at 25.0 — 25.0	EL. 188.0

Boring backfilled with bentonite and cement on 10/30/02. No 24 hr. water level. Classification based on Atterberg limits only. Elevation based on topographic plan.

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO.	B-2
SHEET	1 OF 2
DATE: START	10/30/02
END	10/30/02
O.G. ELEV.	213

PROJECT NAME: Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION: OFFSET: BASELINE:
COORDINATES: NORTH: EAST:
INSPECTOR (SIGNED): Mark Martin DRILLERS NAME/COMPANY: Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED: Geoprobe 66DT Track Rig
DRILLING METHODS: 1-1/2" I.D., 5.0' Sampler
CASING: SIZE: DEPTH: WATER: DEPTH: 4.5 TIME: 0 hrs. DATE: 10/30/02
CHECKED BY: John Callahan DATE: 11/05/02 DEPTH: TIME: DATE:
S.O. NUMBER: 24421-007-0002-00007 FILE: passaic NOT ENCOUNTERED ☐ INCLINATION (DEGREES): 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0	DP-1		5.0	100	2.5-3.5			TOPSOIL; (ml/a-4); dark brown; wet; loose; homogeneous — 0.5	EL. 212.5
								Silty CLAY; (cl-ml/a-4); reddish brown to rust; moist; very stiff, laminated	Glacio-Lacustrine
5.0	DP-2		5.0	100				Encountered water at 5.0'	EL 208.0 DP-2 would not come out of barrel
10.0	DP-3		4.5	90	2.5-3.5				
15.0	DP-4		1.5	30	3.0-4.0			Gray below 18.5'	EL 194.5

Boring backfilled with bentonite and cement on 10/30/02 No 24 hr. water level. Classification based on Atterberg limits only. Elevation based on topographic plan.

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO.	B-5
SHEET	2 OF 2
DATE: START	10/30/02
END	10/30/02
O.G. ELEV.	212.3

PROJECT NAME: Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION: ______ OFFSET: ______ BASELINE: ______
COORDINATES: NORTH: ______ EAST: ______
INSPECTOR (SIGNED): Mark Martin DRILLERS NAME/COMPANY: Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED: Geoprobe 66DT Track Rig
DRILLING METHODS: 1-1/2" I D., 5.0' Sampler
CASING: SIZE: ______ DEPTH: ______ WATER: DEPTH: 2.1 TIME: 0 hrs DATE: 10/30/02
CHECKED BY: John Callahan DATE: 11/05/02 DEPTH: ______ TIME: ______ DATE: ______
S.O. NUMBER: 24421-007-0002-00007 FILE: passaic NOT ENCOUNTERED ☐ INCLINATION (DEGREES): 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
20.0	DP-5		5.0	100	.25-1.0				
25.0								25.0 End of boring at 25 0	EL. 187 3

Boring backfilled with bentonite and cement on 10/30/02. No 24 hr. water level. Classification based on Atterberg limits only. Elevation based on topographic plan

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO.	B-5
SHEET	1 OF 2
DATE: START	10/30/02
END	10/30/02
O.G. ELEV.	212 3

PROJECT NAME: Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION: ______ OFFSET: ______ BASELINE: ______
COORDINATES: NORTH: ______ EAST: ______
INSPECTOR (SIGNED): Mark Martin DRILLERS NAME/COMPANY: Brian Ramos/Land, Air & Water Env Svs
EQUIPMENT USED: Geoprobe 66DT Track Rig
DRILLING METHODS: 1-1/2" I D., 5 0' Sampler
CASING: SIZE: ______ DEPTH: ______ WATER: DEPTH: 2.1 TIME: 0 hrs DATE: 10/30/02
CHECKED BY: John Callahan DATE: 11/05/02 DEPTH: ______ TIME: ______ DATE: ______
S.O. NUMBER: 24421-007-0002-00007 FILE: passaic NOT ENCOUNTERED ☐ INCLINATION (DEGREES): 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0	DP-1		3.5	70	.75-4.5			TOPSOIL w/ Organics, (ml/a-4); black; wet; loose; homogeneous 0.3 Gravelly SILT; (ml/a-4); reddish brown and tan; moist; loose to medium dense; homogeneous 2.0 PEAT; (pt/-); dark gray; wet; loose; homogeneous 2 5 Silty CLAY; (cl-ml/a-4); gray and brown mottled to reddish brown; moist, medium stiff to hard, -PL to NPL, laminated encountered water at 5.0'	EL. 212 0 EL. 210 3 organics EL. 209.8 Glacio-Lacustrine EL. 207 3
5 0	DP-2		4 6	92	1.75-3	CL / A-4	25 7		
10 0	DP-3		4 2	84	1.75-3				
15 0	DP-4		5.0	100	0.5-1 0	CL / A-4	27 3	soft to medium stiff below 15.0' gray below 17 5	EL 197 3 EL 194.8

Boring backfilled with bentonite and cement on 10/30/02. No 24 hr water level. Classification based on Atterberg limits only. Elevation based on topographic plan

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO.	B-4
SHEET	2 OF 2
DATE: START	10/30/02
END	10/30/02
O.G. ELEV.	212.3

PROJECT NAME: Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION: ______ OFFSET: ______ BASELINE: ______
COORDINATES: NORTH: ______ EAST: ______
INSPECTOR (SIGNED): Mark Martin DRILLERS NAME/COMPANY: Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED: Geoprobe 66DT Track Rig
DRILLING METHODS: 1-1/2" I.D., 5.0' Sampler
CASING: SIZE: ______ DEPTH: ______ WATER: DEPTH: 5.4 TIME: 0 hrs. DATE: 10/30/02
CHECKED BY: John Callahan DATE: 11/05/02 DEPTH: ______ TIME: ______ DATE: ______
S.O. NUMBER: 24421-007-0002-00007 FILE: passaic NOT ENCOUNTERED ☐ INCLINATION (DEGREES): 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
20 0	DP-5		5.0	100	.25- 75	ML / A-4	29 7	very soft to medium stiff, +PL, wet below 20 0'	EL. 192 3
25 0								25.0 End of boring at 25 0	EL. 187.3

Boring backfilled with bentonite and cement on 10/30/02. No 24 hr water level. Classification based on Atterberg limits only. Elevation based on topographic plan

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO.	B-4
SHEET	1 OF 2
DATE: START	10/30/02
END	10/30/02
O.G. ELEV.	212.3

PROJECT NAME: Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION: ______ OFFSET: ______ BASELINE: ______
COORDINATES: NORTH: ______ EAST: ______
INSPECTOR (SIGNED): Mark Martin DRILLERS NAME/COMPANY: Brian Ramos/Land, Air & Water Env Svs
EQUIPMENT USED: Geoprobe 66DT Track Rig
DRILLING METHODS: 1-1/2" I.D., 5 0' Sampler
CASING: SIZE: ______ DEPTH: ______ WATER: DEPTH: 5 4 TIME: 0 hrs. DATE: 10/30/02
CHECKED BY: John Callahan DATE: 11/05/02 DEPTH: ______ TIME: ______ DATE: ______
S.O. NUMBER: 24421-007-0002-00007 FILE: passaic NOT ENCOUNTERED ☐ INCLINATION (DEGREES): 0

DEPTH (FT.)	SAMPLE NO AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0	DP-1		2.8	56	2 0-4.0			TOPSOIL; (ml/a-4); orange-brown, moist; loose, homogeneous 1.0 Silty GRAVEL; (gm/a-1-b), black, gray, brown and orange, moist; medium dense; homogeneous, gravel is angular, fine to coarse, granite fragments 2 0 Silty CLAY; (cl-ml/a-4); gray to reddish brown; moist, stiff to hard, -PL to NPL; laminated	some fill EL 211 3 fill EL 210 3 Glacio-Lacustrine
5 0	DP-2		4.7	94	2.0-2.5				
10.0	DP-3		5.0	100	0 5-2 0			encountered water at 10 5' 0.3' - gravel zone at 11.2' medium stiff to stiff below 11.5' gray below 13.5	EL. 201.8 EL. 201.1 EL. 200 8 EL 198.8
15.0	DP-4		4 5	90	.25-1 0			soft to medium stiff, +PL, below 17.5'	EL 194.8

Boring backfilled with bentonite and cement on 10/30/02. No 24 hr. water level. Classification based on Atterberg limits only Elevation based on topographic plan.

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO. B-7
SHEET 2 **OF** 2
DATE: START 10/29/02
END 10/29/02
O.G. ELEV. 212 5

PROJECT NAME Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION **OFFSET** **BASELINE**
COORDINATES: NORTH: **EAST:**
INSPECTOR (SIGNED) Mark Martin **DRILLERS NAME/COMPANY** Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED Geoprobe 66DT Track Rig
DRILLING METHODS 1-1/2" I.D., 5 0' Sampler
CASING: SIZE: **DEPTH:** **WATER: DEPTH:** dry **TIME:** 0 hrs. **DATE:** 10/29/02
CHECKED BY: John Callahan **DATE:** 11/05/02 **DEPTH:** **TIME:** **DATE:**
S.O. NUMBER: 24421-007-0002-00007 **FILE:** passaic **NOT ENCOUNTERED** ☒ **INCLINATION (DEGREES):** 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
20.0	DP-5		5 0	100	.75-1.5	CH / A-7-6	39 5	soft to medium stiff below 20.0	EL. 192 5
25 0								25 0 End of boring at 25.0	EL. 187 5

Boring backfilled with bentonite and cement on 10/30/02. Classifications based on Atterberg limits only. Elevation based on topographic plan

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO. B-7
SHEET 1 **OF** 2
DATE: START 10/29/02
END 10/29/02
O.G. ELEV. 212 5

PROJECT NAME Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION **OFFSET** **BASELINE**
COORDINATES: NORTH: **EAST:**
INSPECTOR (SIGNED) Mark Martin **DRILLERS NAME/COMPANY** Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED Geoprobe 66DT Track Rig
DRILLING METHODS 1-1/2" I.D., 5.0' Sampler
CASING: SIZE: **DEPTH:** **WATER: DEPTH:** dry **TIME:** 0 hrs. **DATE:** 10/29/02
CHECKED BY: John Callahan **DATE:** 11/05/02 **DEPTH:** **TIME:** **DATE:**
S.O. NUMBER: 24421-007-0002-00007 **FILE:** passaic **NOT ENCOUNTERED** ☒ **INCLINATION (DEGREES):** 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
	DP-1		2 7	54	2 5-4.5			Silty CLAY; (cl-ml/a-4); reddish brown and tan; moist; medium stiff to hard; -PL to NPL, laminated	Glacio-Lacustrine
5.0	DP-2		5.0	100	2.5-3.5	CH / A-7-6	33.8		
10.0	DP-3		4 5	90	.75-2 0				
15.0	DP-4		5 0	100				gray below 15.0	EL 197.5 Sample DP-4 would not come out of the barrel

Boring backfilled with bentonite and cement on 10/30/02 Classifications based on Atterberg limits only. Elevation based on topographic plan

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO. B-6
SHEET 2 **OF** 2
DATE: START 10/30/02
END 10/30/02
O.G. ELEV. 212 5

PROJECT NAME Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION **OFFSET** **BASELINE**
COORDINATES: NORTH: **EAST:**
INSPECTOR (SIGNED) Mark Martin **DRILLERS NAME/COMPANY** Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED Geoprobe 66DT Track Rig
DRILLING METHODS 1-1/2" I D., 5.0' Sampler
CASING: SIZE: **DEPTH:** **WATER: DEPTH:** 2 0 **TIME:** 0 hrs. **DATE:** 10/30/02
CHECKED BY: John Callahan **DATE:** 11/05/02 **DEPTH:** **TIME:** **DATE:**
S.O. NUMBER: 24421-007-0002-00007 **FILE:** passaic **NOT ENCOUNTERED** ☐ **INCLINATION (DEGREES):** 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
20.0								20.0 End of boring at 20.0	EL 192 5

Boring backfilled with bentonite and cement on 10/30/02 No 24 hr. water level. Classifications based on Atterberg limits only. Elevation based on topographic plan

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO. B-6
SHEET 1 **OF** 2
DATE: START 10/30/02
END 10/30/02
O.G. ELEV. 212 5

PROJECT NAME Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION **OFFSET** **BASELINE**
COORDINATES: NORTH: **EAST:**
INSPECTOR (SIGNED) Mark Martin **DRILLERS NAME/COMPANY** Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED Geoprobe 66DT Track Rig
DRILLING METHODS 1-1/2" I.D., 5 0' Sampler
CASING: SIZE: **DEPTH:** **WATER: DEPTH:** 2.0 **TIME:** 0 hrs. **DATE:** 10/30/02
CHECKED BY: John Callahan **DATE:** 11/05/02 **DEPTH:** **TIME:** **DATE:**
S.O. NUMBER: 24421-007-0002-00007 **FILE:** passaic **NOT ENCOUNTERED** ☐ **INCLINATION (DEGREES):** 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
	A-N							Silty GRAVEL; (gm/a-1-b); gray, brown and red; wet to moist, loose, homogeneous; gravel is angular, coarse, granite fragments	fill/gravel apron
1.0	DP-1		2 8	70	.75-4.0			1 5 Silty CLAY, (cl-ml/a-4); brown, tan and gray to reddish brown w/ dark brown mottling; medium stiff to very stiff; -PL to NPL, homogeneous to laminated	EL. 211.0 Glacio-Lacustrine
5.0	DP-2		5 0	100	2 5-3.5	CL / A-4	24 8	encountered water at 5 0	EL 207 5
10 0	DP-3		5.0	100	2 2-2 5				
15 0	DP-4		5 0	100	.75-2.2	CL / A-4	27.6	brownish gray below 15 0	EL 197.5

Boring backfilled with bentonite and cement on 10/30/02. No 24 hr. water level Classifications based on Atterberg limits only Elevation based on topographic plan.

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO. B-8
SHEET 1 **OF** 2
DATE: START 10/29/02
END 10/29/02
O.G. ELEV. 209.0

PROJECT NAME Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION ______ **OFFSET** ______ **BASELINE** ______
COORDINATES: NORTH: ______ **EAST:** ______
INSPECTOR (SIGNED) Mark Martin **DRILLERS NAME/COMPANY** Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED Geoprobe 66DT Track Rig
DRILLING METHODS 1-1/2" I.D , 5 0' Sampler
CASING: SIZE: ______ **DEPTH:** ______ **WATER: DEPTH:** dry **TIME:** 0 hrs **DATE:** 10/29/02
CHECKED BY: John Callahan **DATE:** 11/05/02 **DEPTH:** ______ **TIME:** ______ **DATE:** ______
S.O. NUMBER: 24421-007-0002-00007 **FILE:** passaic **NOT ENCOUNTERED** ☒ **INCLINATION (DEGREES):** 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
0	DP-1		5 0	100	1.0-3 7 3 75			TOPSOIL; (ml/a-4); dark brown, brown and orange, moist; medium stiff to very stiff; NPL; homogeneous 1.5 SILT; (ml/a-4); brown to reddish brown mottled gray; moist, very stiff to hard, -pl; laminated	roots and organics throughout EL 207.5 Glacio-Lacustrine
5.0	DP-2		5.0	100	3.7-4 5	ML / A-7-6	27.9		
10 0	DP-3		5 0	100	1.0-2 2	CH / A-7-6	36.6	10.0 Lean CLAY; (cl/a-6); brown to gray, moist; stiff to very stiff; NPL to +PL; laminated gray below 13 0'	EL 199.0 Glacio-Lacustrine EL. 196 0
15 0	DP-4		5 0	100					Sample DP-4 would not come out of barrel

Boring backfilled with bentonite and cement on 10/30/02 Classifications based on Atterberg limits only. Elevation based on topographic plan

BKR_E (LD4)
(02/01 Baker)

ENGINEERS FIELD BORING LOG

BORING NO. B-8
SHEET 2 **OF** 2
DATE: START 10/29/02
END 10/29/02
O.G. ELEV. 209 0

PROJECT NAME Passaic River Flood Wall Project
LOCATION: Stirling, NJ
STATION ______ **OFFSET** ______ **BASELINE** ______
COORDINATES: NORTH: ______ **EAST:** ______
INSPECTOR (SIGNED) Mark Martin **DRILLERS NAME/COMPANY** Brian Ramos/Land, Air & Water Env.Svs
EQUIPMENT USED Geoprobe 66DT Track Rig
DRILLING METHODS 1-1/2" I D , 5 0' Sampler
CASING: SIZE: ______ **DEPTH:** ______ **WATER: DEPTH:** dry **TIME:** 0 hrs. **DATE:** 10/29/02
CHECKED BY: John Callahan **DATE:** 11/05/02 **DEPTH:** ______ **TIME:** ______ **DATE:** ______
S.O. NUMBER: 24421-007-0002-00007 **FILE:** passaic **NOT ENCOUNTERED** ☒ **INCLINATION (DEGREES):** 0

DEPTH (FT.)	SAMPLE NO. AND TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.) / RQD (FT.)	RECOVERY (%) / RQD (%)	POCKET PENET or TORVANE (TSF)	USCS / AASHTO	H_2O CONTENT	DESCRIPTION	REMARKS
20 0	DP-5		5.0	100	.25-.75 .75-1 5			22.0 SILT; (ml/a-4), reddish brown; moist; medium stiff to stiff, NPL to +PL; homogeneous	EL. 187 0
25.0								25.0 End of boring at 25 0	EL 184.0

Boring backfilled with bentonite and cement on 10/30/02. Classifications based on Atterberg limits only. Elevation based on topographic plan.

ATTACHMENT B
LABORATORY TESTS

ACKENHEIL ENGINEERS, INC.
Civil • Environmental • Materials Testing

NATURAL WATER CONTENT

Project: Passaic River Flood Wall Project
Client: Michael Baker Jr., Inc.
Date: 11-11-02

Boring No.	Sample No.	Depth (feet)	Water Content (%)
B-1	na	5.8 to 6.3	24.8
B-2	na	24.6 to 24.8	43.8
B-4	na	24.7 to 25.0	29.7
B-5	na	9 4 to 10.0	25.7
B-5	na	19.0 to 19.4	27.3
B-6	na	8.4 to 8.8	24.8
B-6	na	16.0 to 16.4	27.6
B-7	na	7.8 to 8.2	33.8
B-7	na	21.2 to 21.6	39.5
B-8	na	6.9 to 7.3	27.9
B-8	na	12.3 to 12.8	36.6
B-8	na	15.0 to 20.0	40.1

1000 Banksville Road • Pittsburgh, PA 15216 • 412-531-7111 • FAX 412-531-4334

ACKENHEIL ENGINEERS, INC.
Civil • Environmental • Materials Testing

ATTERBERG LIMITS

Project: Passaic River Flood Wall Project
Client: Michael Baker Jr., Inc.
Date: 11-11-02

Boring No./ Depth	Liquid Limit	Plastic Limit	Plasticity Index
B-1 / 5.8 to 6.3 ft.	55	29	26
B-2 / 24.6 to 24.8 ft.	60	31	29
B-4 / 24.7 to 25.0 ft.	33	24	9
B-5 / 9.4 to 10.0 ft.	33	23	10
B-5 / 19.0 to 19.4 ft.	29	22	7
B-6 / 8.4 to 8.8 ft.	32	22	10
B-6 / 16.0 to 16.4 ft.	32	23	9
B-7 / 7.8 to 8.2 ft.	57	29	28
B-7 / 21.2 to 21.6 ft.	58	28	30
B-8 / 6.9 to 7.3 ft.	46	27	19
B-8 / 12.3 to 12.8 ft.	59	28	31
B-8 / 15.0 to 20.0 ft.	56	29	27

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Upper Passaic River
Long Hill Township
Flood Control Project
GEOTECHNICAL DESIGN MEMORANDUM

Upper Passaic River
Long Hill Township
Flood Control Project
GEOTECHNICAL DESIGN MEMORANDUM

TABLE OF CONTENTS PAGE

1.0 INTRODUCTION

Baker conducted a feasibility study for a flood control project for the New York District Corps of Engineers. The site is a wooded floodplain near the town of Stirling, NJ in Long Hill Township in southern Morris County near the Somerset County-Warren Township border. It is 15 miles southwest of Newark, NJ and south of the Great Swamp National Wildlife Refuge.

Proposed structural alternatives considered for improvements along Passaic Valley Road include levees, floodwalls, and culvert crossings. A report entitled, *Upper Passaic River, Long Hill Township, Flood Control Project: Geotechnical Investigation Report* was completed in December 2002. The report included evaluation of existing published data and data collected in the field investigation. The field data consists of test borings, soil sampling, and laboratory testing. The geotechnical investigation and report were accompanied by simultaneous efforts addressing preliminary structural design, hydrology/hydraulics analysis, and cost estimates. Together, these studies provide a preliminary evaluation of the structural alternatives.

The purpose of this *Geotechnical Design Memorandum* is to document: 1) geotechnical parameters (presumed) of earth materials, 2) an assessment of the stability of the design alternatives (freestanding sheet pile floodwall and earth embankment levee), 3)Recommendations for reconstructed roadways, 4) seepage analysis through the railroad embankment, 5) preliminary foundation recommendations and 6) recommendations for further investigations.

2.0 SUBSURFACE CONDITIONS

A general discussion of subsurface conditions as revealed by the borings appears in the Geotechnical Investigation Report noted above. Specific subsurface conditions at boring locations are indicated in detail on the boring logs and geologic cross section included in that report. Subsurface conditions for the levee segment of the proposed flood control structure are indicated by borings B-1 and (near) B-2. Subsurface conditions for the proposed floodwall segment are indicated by borings B-2 through B-7. Boring B-8 characterizes a culvert location where the flood control will be accomplished by enhancing the existing Passaic Valley Road embankment to form a levee.

2.1 Soil Stratigraphy

The predominant subsurface material in the project area, as shown in borings B-1 through B-7, is silty clay of glacio-lacustrine origin. This unit represents the material upon which the levee will bear and within which most of the buried portion of the sheet piles will be embedded. Fine-grained glacio-lacustrine deposits extended through the total depth of boring in all but boring B-1. Boring B-1 penetrated residuum derived from shale at a depth of 7.0 ft. In addition to this predominant material type, thin topsoil (1.0 ft or less) was encountered in borings B-2 through B-5. A unit of underlying gravelly silt / silty gravel (probably fill) was found in borings B-4, B-5 and B-6 that measured 1.0 ft, 1.7 ft and 1.5 ft, respectively. A 0.5 ft thick layer of peat was encountered under this gravelly silt layer in boring B-5. Boring B-8 near the culvert displayed a distinct stratigraphy consisting of alternating thick layers of silt and clay.

A continuous push geoprobe was used to advance the borings and no SPT data was gathered. Therefore, consistency categories were correlated with the direct readings of unconfined compressive strength obtained through pocket penetrometer readings on the sampled soil. Borings B-1 and B-2 displayed very stiff to hard and very stiff consistencies, respectively, in the glacio-lacustrine material throughout the total depth of borings. Likewise, the glacio-lacustrine material in boring B-6 was found to be in the medium stiff to very stiff range throughout total depth. In the remaining borings, however, this material displayed a stiffer layer overlying a softer layer. Although these borings ranged from medium stiff to hard in the upper layer, they all contained at least some soft material in the lower layer, beginning from 10 to 17.5 feet below the ground surface. Pocket penetrometer readings, taken for each soil type, appear on the boring logs.

2.2 Analytical Model

Soil descriptions and penetrometer readings were plotted by elevation and the profiles of all eight borings were compared to develop a conservative but representative subsurface layering model for use in preliminary analysis. The model derived from this comparison consisted of :

> 5 feet of clay fill from 217 (top of levee) to 212 ft-msl (bottom of levee and base of floodwall), overlying
>
> 10 feet of glacio-lacustrine clay from 212 to 202 ft-msl, overlying,
>
> 5 feet of glacio-lacustrine clay from 202 to 197 ft-msl, overlying,
>
> 12 feet of glacio-lacustrine clay from 197 to 185 ft-msl.

3.0 SOIL PROPERTIES

Presumptive soil properties for the layering model used in preliminary analysis were derived from Table 1: Typical Properties of Compacted Soils (in the Naval Facilities Engineering Command Design Manual 7.02: *Foundations and Earth Structures*) and experience with similar soils. The parameters selected to represent soft to medium stiff silty clay (CH) soils with an effective angle of internal friction of 15 degrees and a cohesion of 150 to 200 psf. These properties are included in the Attachments A and B for embankment and sheet pile wall stability, respectively.

4.0 FLOODWALL

Vinyl sheet piling, driven by means of a protective mandrel, has been evaluated for use as a floodwall structure as an alternate to steel sheet piling at the request of the Corps of

Engineers. The floodwall begins at Station 3+50 and ends at Station 39+50 as shown in Figure 1. Actual wall height will vary from one foot to a maximum of five feet.
The section analyzed consisted of a five feet high freestanding wall segment, reaching from the assumed ground elevation of 212 ft-msl to an assumed top-of-wall elevation at 217 ft-msl. The buried segment of the wall penetrates to eleven feet below the assumed ground surface to a tip elevation of 201 ft-msl. The water level was assumed to be at the top-of-wall for the simulated worst-case conditions. Overtopping was not evaluated in this analysis. The properties of Shoreguard 950 vinyl sheet piling was used in the analysis.

The maximum moment induced on the sheet piling was well within the allowable value. With an embedment depth of 10.8 feet, the deflection of the freestanding segment, with no tiebacks, was slightly over 1.0 inches. A typical Retaining Wall Section and the extent of the proposed floodwall structure appear in the Figure 2 of this report. Wall calculations are in Appendix B.

To prevent leakage in the joints between the sheeting, a gasket or sealant can be used. There are hydrophilic sealers (for example – Adeka Ultra Seal) that are applied before pile installation and expand when in contact with water. The longevity of these sealers has to be investigated further.

The advantages of vinyl sheeting over steel sheeting are mainly related to the longer service life of the vinyl sheeting. The vinyl sheets will not corrode, rust, crack or peel and are virtually maintenance free. Since the sheets do not degrade the maintain a good appearance for an unlimited time, they would be a compatible feature in a residential area such as this project.

Installation is facilitated by the fact that the sheets are much lighter and more easily handled. Since they are lighter, they are usually wider than steel sheets and therefore less sheets must be installed, which should reduced installation time.

According to the vinyl sheeting advertising literature, the cost of the vinyl sheeting is much less than steel, although there is little historical bid pricing to verify this claim..

On the negative side the strength of the sheets is limited. A much greater section modulus of the vinyl sheet would be required to resist the same bending moment when compared to a steel sheet. However, in applications where the bending moment to be resisted is low enough that vinyl sheets can provide sufficient bending resistance (as in the case of this project) the lower strength of the vinyl sheets is less critical.

When the vinyl sheet can provide sufficient strength to resist the design moment, the advantages of vinyl sheets mentioned above, make selection of vinyl sheeting an attractive alternative to steel.

The advantages of steel sheet piling for this project are mainly the durability and higher strength of the steel. In areas where the wall is in close proximity to vehicles, especially snow plows, steel sheet piling can take impacts with less damage than vinyl. Guardrails are would be required for either wall. Steel sheeting is less susceptible to damage from vandalism and heat from fires.

5.0 LEVEE

A five feet high typical levee structure with 3H:1V side slopes and a 15 feet wide top was analyzed for slope stability using the STABL program. Rapid draw down conditions were assumed for the worst-case hydrologic conditions, although these conditions may be unrealistically conservative for typical flooding which is likely to be too brief to fully saturate the embankment.

Engineered fill consisting of clay typical of the area was the assumed embankment material. The simulated conditions yielded a global factor of safety of 3.1 under static conditions, well above the required 1.5 factor of safety generally required for embankments.

The preliminary location of the levee is between Station 0+00 and Station 3+50 (Figure 1). The height of the levee will vary from one foot to five feet. Seepage below the levee will be negligible because of the low permeability clay foundation. Seepage through the levee will also be negligible is locally available clay borrow is used.

6.0 GATED CULVERTS

There are three gated culverts: at Station 0+00 near Boring B-1, Station 30+50 near Boring B-6 and Warren Avenue, and near Boring B-8 and Western Boulevard at Mark’s Auto Service. In each of these areas the foundation materials are glacial lacustrine clays. With a preliminary foundation grade of elevation 208, the silty clays at these locations have unconfined compressive strengths of 2.0 to 4.0 tsf based on pocket penetrometer readings. Using the lower value of 2.0 tsf, the allowable bearing capacity is also 2.0 tsf. This agrees well with a presumptive allowable bearing pressure of 2.0 tsf given in military geotechnical references (NAVFAC DM-7).

Pile foundations are an alternative because the ground water table may be above the foundation elevation. Wood or concrete friction piling should develop a 20-ton capacity in the silty clay if driven to a depth of 35 feet. At the Culvert at Station 0+00, the piles should penetrate bedrock at approximately elevation 200.

7.0 PUMP STATIONS

At this time pump stations are expected to be mobile units. If permanents pump station locations are selected, it is likely that foundation soils will be silty clay similar to the gated culvert locations. Test borings for final design should be made to determine soil conditions at permanent pump station locations.

8.0 IMPROVEMENTS TO VALLEY ROAD AND MOUNTAIN AVENUE

Any road that must be raised and rebuilt, such as Mountain Avenue north of the railroad crossing and Passaic Valley Road at the proposed gated culvert near Western Boulevard, should be designed according to New Jersey DOT standards for width, shoulders, base course, and pavement. Reconstruction of residential streets should follow procedures established by the governing municipality. Subgrade properties will depend on the composition of available borrow soils and corresponding CBR values.

9.0 POSSIBLE BORROW SITES

Potential borrow site locations are unknown at this time. Potential borrow sites should be selected and investigated in the next design stage.

10.0 SEEPAGE AT RAILROAD EMBANKMENT

An analysis of seepage through the New Jersey Transit railroad embankment was done to determine pumping requirements for this source of backwater. The embankment cross-section was determined from photographs because a surveyed cross section was not available. An assumption of embankment materials was made because there is no test boring information at this time. Although the side slopes are covered with crushed rock ballast, it is likely that most of the embankment consists of earth. The typical section for the seepage analysis has the following dimensions:

- 15 feet top width
- 2H to 1V side slopes
- Track elevation of 216
- Headwater elevation of 214 on the north side
- Embankment base of elevation 210
- Tailwater elevation of 210 on the south side

Two embankment soil types were considered. One soil type is a silty clay similar to the lacustrine soils of the area. The estimated permeability of this soil is 1×10^{-6} cm/sec. The second soil type is a sandy soil with an estimated permeability of 1×10^{-3} cm/sec.

The stretch of railroad considered to be critical with respect to seepage into the area protected by this project is the embankment length from Morristown Road to Mountain Avenue – a distance of 3100 feet. Seepage may also occur through 300 feet of Morristown Road embankment.

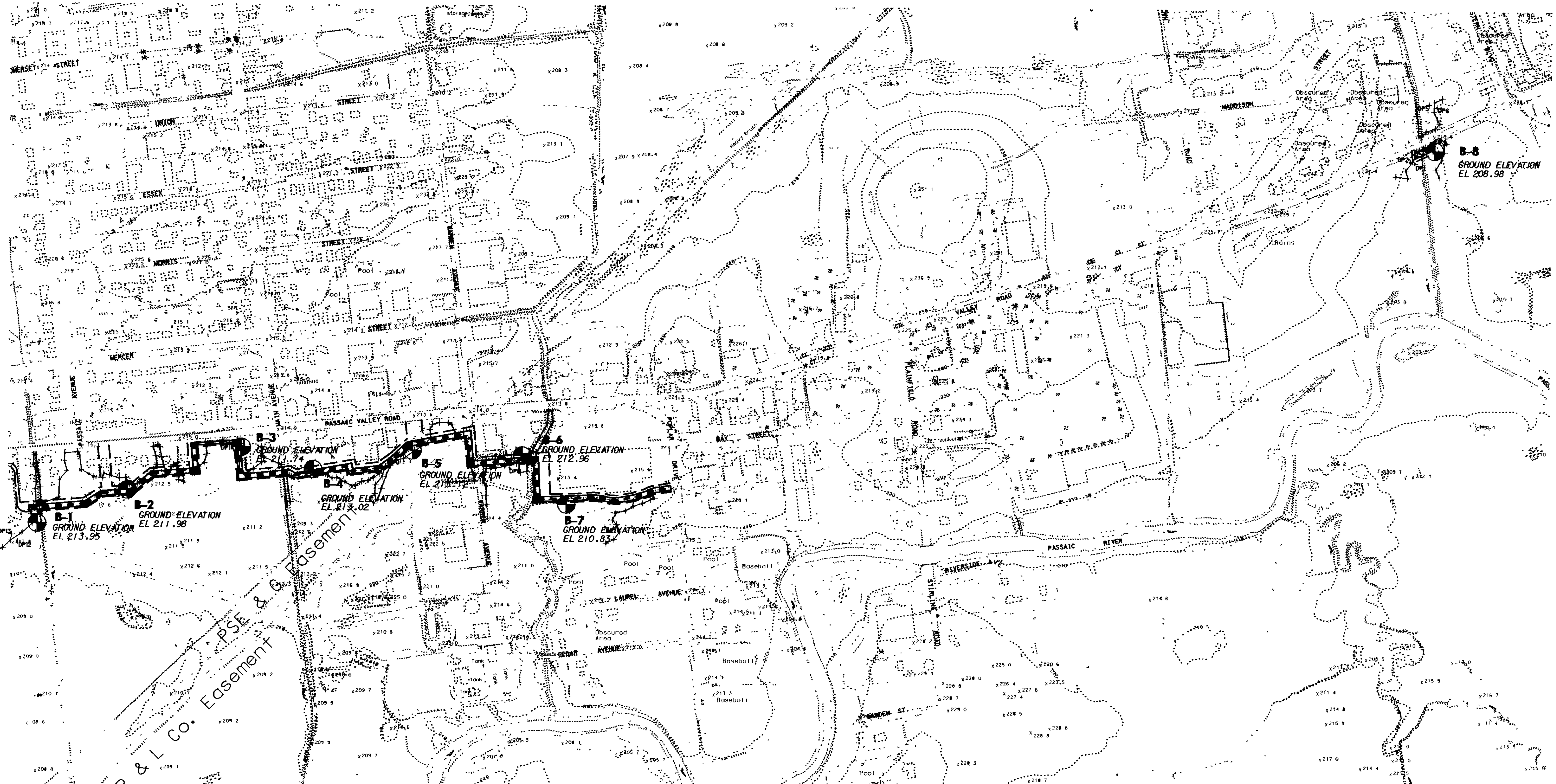
The seepage calculations through embankment composed of either clay or sandy soil show a quantity of less than one cfs along 3400 of railroad and road embankments. However, if the embankment is composed entirely of crushed stone (permeability = $1 \times 10^{+1}$ cm/sec), the seepage total would be approximately 250 cfs and significant pumping would be required. The next phase of the project should include test borings to determine the composition of the embankment materials.

11.0 ADDITIONAL FIELD AND LABORATORY INVESTIGATION

For the next design stage, the following geotechnical information will be needed:

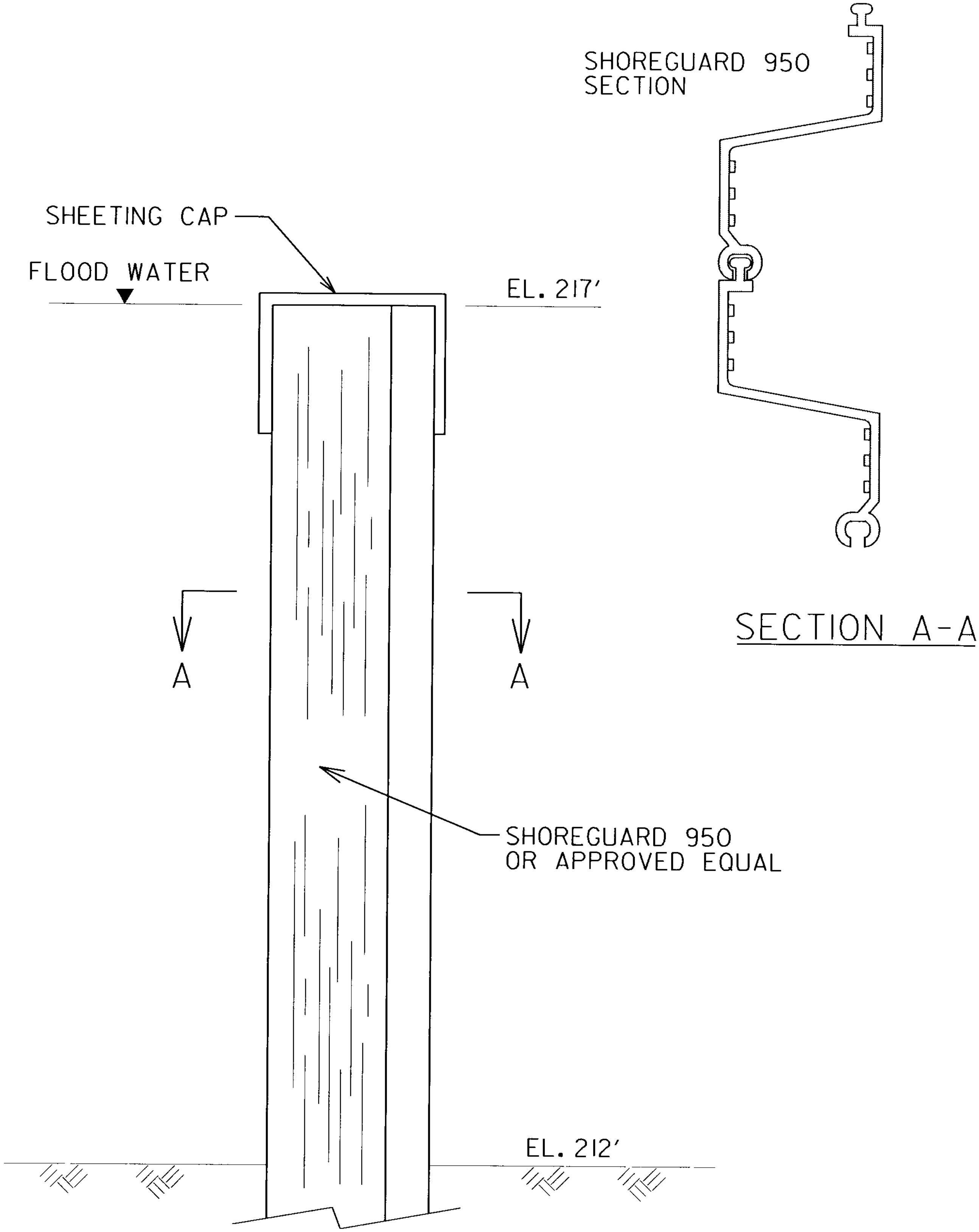
1) Test borings, standard penetration tests, and undisturbed soil samples at pump station locations, gated culverts, floodwalls, levees, the NJT railroad embankment, and rebuilt roadways.
2) Test pits or borings in potential borrow areas.
3) Laboratory testing for: soil classification (Atterberg limits and Grain size distribution), unconfined compression tests, direct shear tests, and consolidation tests for silty clay foundation soils.
4) Laboratory testing for: soil classification (Atterberg limits and Grain size distribution), proctor density tests, and CBR tests on levees and roadway embankment soils from potential borrow areas.

FIGURES



REVISIONS	DESIGNED DRAWN CHECKED REVIEWED S.O. CADD FILE	MICHAEL BAKER JR., INC. CONSULTING ENGINEERS BEAVER, PENNSYLVANIA	Baker	FIGURE 1 PRELIMINARY LOCATION OF STRUCTURES AND TEST BORING LOCATIONS	SHEET NO. OF
				SCALE: 1" = 500'	DATE: 4-10-03

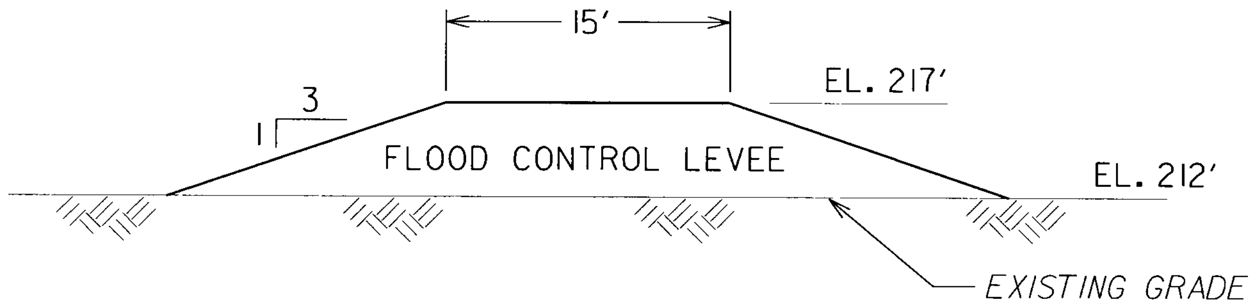
R:\GEOTECH\Upper_passaic\PLAN\BORINGPLAN.dgn APR-2003



TYPICAL SECTION OF FLOOD WALL

UPPER PASSAIC RIVER FLOOD CONTROL PROJECT

SCALE: N.T.S. S.O. NO. DATE: 11/25/02 FILE: SHEET_PILE_DTL.DGN	Baker — **Michael Baker Jr., Inc.** *A Unit of Michael Baker Corporation* 4301 Dutch Ridge Road Beaver, Pennsylvania 15009	FIGURE 2



TYPICAL SECTION OF FLOOD WALL

UPPER PASSAIC RIVER FLOOD CONTROL PROJECT

SCALE: N.T.S. S.O. NO.

DATE: 11/25/02 FILE: SHEET_PILE_DTL.DGN

Baker

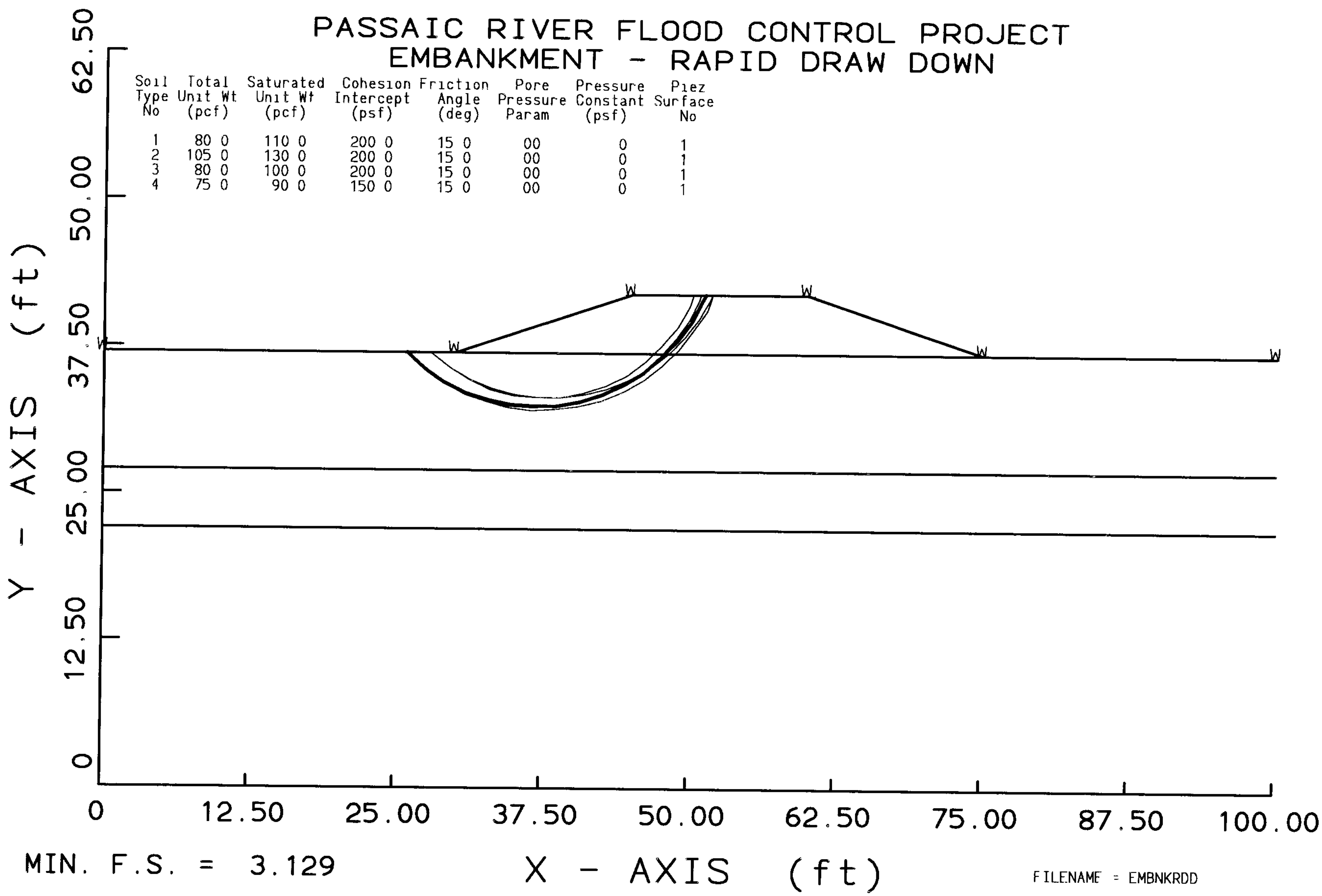
Michael Baker Jr., Inc.
A Unit of Michael Baker Corporation
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009

FIGURE 3

ATTACHMENT A
LEVEE EMBANKMENT STABILITY

PASSAIC RIVER FLOOD CONTROL PROJECT
EMBANKMENT - RAPID DRAW DOWN

Soil Type No	Total Unit Wt (pcf)	Saturated Unit Wt (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param	Pressure Constant (psf)	Piez Surface No
1	80 0	110 0	200 0	15 0	00	0	1
2	105 0	130 0	200 0	15 0	00	0	1
3	80 0	100 0	200 0	15 0	00	0	1
4	75 0	90 0	150 0	15 0	00	0	1



MIN. F.S. = 3.129

FILENAME = EMBNKRDD

** PASTABLE **

Adapted From PCSTABL6
by
Pennsylvania Department of Transportation
Geotechnical Section
(English Ver. of PASTABLM 2/97)

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	11-14-02
Time of Run:	7:47 A.M.
Run By:	REC
Input Data Filename:	EMBNKRDD.IN
Output Filename:	EMBNKRDD.OUT
Plotted Output Filename:	EMBNKRDD.PLT

PROBLEM DESCRIPTION   EMBANKMENT - RAPID DRAW DOWN CASE

BOUNDARY COORDINATES

5 Top Boundaries
8 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	37.00	30.00	37.00	2
2	30.00	37.00	45.00	42.00	1
3	45.00	42.00	60.00	42.00	1
4	60.00	42.00	75.00	37.00	1
5	75.00	37.00	100.00	37.00	2
6	30.00	37.00	75.00	37.00	2
7	.00	27.00	100.00	27.00	3
8	.00	22.00	100.00	22.00	4

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil   Total   Saturated   Cohesion   Friction   Pore   Pressure   Piez.

Type No.	Unit Wt. (pcf)	Unit Wt. (pcf)	Intercept (psf)	Angle (deg)	Pressure Param.	Constant (psf)	Surface No.
1	80.0	110.0	200.0	15.0	.00	.0	1
2	105.0	130.0	200.0	15.0	.00	.0	1
3	80.0	100.0	200.0	15.0	.00	.0	1
4	75.0	90.0	150.0	15.0	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40 pcf

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	37.00
2	30.00	37.00
3	45.00	42.00
4	60.00	42.00
5	75.00	37.00
6	100.00	37.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

900 Trial Surfaces Have Been Generated.

30 Surfaces Initiate From Each Of 30 Points Equally Spaced
Along The Ground Surface Between X = .00 ft.
and X = 30.00 ft.

Each Surface Terminates Between X = 35.00 ft.
and X = 60.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

2.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	25.86	37.00
2	27.36	35.68
3	29.02	34.56
4	30.81	33.67
5	32.70	33.01
6	34.66	32.60
7	36.65	32.44
8	38.65	32.54
9	40.62	32.90
10	42.52	33.50
11	44.34	34.35
12	46.02	35.42
13	47.56	36.70
14	48.92	38.17
15	50.08	39.79
16	51.03	41.56
17	51.20	42.00

Circle Center At X = 36.9 ft.; Y = 48.0 ft. and Radius, 15.6 ft.

*** 3.129 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	25.86	37.00
2	27.34	35.65
3	28.98	34.51
4	30.76	33.59
5	32.64	32.92
6	34.60	32.50
7	36.59	32.34
8	38.59	32.44
9	40.55	32.81
10	42.45	33.44
11	44.25	34.31
12	45.92	35.41

13	47.43	36.72
14	48.76	38.21
15	49.88	39.87
16	50.76	41.67
17	50.88	42.00

Circle Center At X = 36.8 ft.; Y = 47.5 ft. and Radius, 15.1 ft.

*** 3.134 ***

1

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	27.93	37.00
2	29.47	35.73
3	31.18	34.69
4	33.03	33.91
5	34.96	33.41
6	36.95	33.19
7	38.95	33.26
8	40.92	33.62
9	42.81	34.27
10	44.59	35.17
11	46.22	36.33
12	47.67	37.71
13	48.90	39.29
14	49.89	41.03
15	50.27	42.00

Circle Center At X = 37.5 ft.; Y = 47.0 ft. and Radius, 13.8 ft.

*** 3.138 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	25.86	37.00
2	27.34	35.65
3	28.97	34.49
4	30.74	33.55
5	32.61	32.84
6	34.55	32.38
7	36.54	32.16
8	38.54	32.19

9	40.52	32.48
10	42.44	33.01
11	44.29	33.78
12	46.02	34.78
13	47.62	35.99
14	49.05	37.39
15	50.29	38.95
16	51.32	40.67
17	51.91	42.00

Circle Center At X = 37.3 ft.; Y = 48.0 ft. and Radius, 15.8 ft.

*** 3.141 ***

1

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	27.93	37.00
2	29.52	35.78
3	31.25	34.78
4	33.10	34.01
5	35.03	33.50
6	37.01	33.23
7	39.01	33.23
8	40.99	33.49
9	42.93	34.01
10	44.77	34.77
11	46.51	35.77
12	48.09	36.99
13	49.51	38.40
14	50.73	39.98
15	51.73	41.72
16	51.85	42.00

Circle Center At X = 38.0 ft.; Y = 48.5 ft. and Radius, 15.3 ft.

*** 3.154 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	26.90	37.00
2	28.47	35.76
3	30.17	34.72

4	31.99	33.88
5	33.89	33.25
6	35.85	32.86
7	37.84	32.69
8	39.84	32.76
9	41.82	33.06
10	43.75	33.59
11	45.60	34.34
12	47.36	35.30
13	48.99	36.46
14	50.47	37.80
15	51.79	39.30
16	52.92	40.95
17	53.48	42.00

Circle Center At X = 38.3 ft.; Y = 49.8 ft. and Radius, 17.1 ft.

*** 3.177 ***

1

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.83	37.00
2	26.24	35.59
3	27.82	34.35
4	29.52	33.31
5	31.34	32.48
6	33.25	31.87
7	35.21	31.49
8	37.21	31.34
9	39.20	31.44
10	41.18	31.77
11	43.10	32.33
12	44.94	33.11
13	46.67	34.11
14	48.27	35.30
15	49.73	36.68
16	51.00	38.22
17	52.09	39.89
18	52.97	41.69
19	53.08	42.00

Circle Center At X = 37.4 ft.; Y = 48.2 ft. and Radius, 16.9 ft.

*** 3.178 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	27.93	37.00
2	29.38	35.62
3	31.03	34.49
4	32.84	33.65
5	34.77	33.10
6	36.75	32.87
7	38.75	32.97
8	40.71	33.39
9	42.57	34.11
10	44.29	35.13
11	45.83	36.41
12	47.14	37.92
13	48.19	39.62
14	48.95	41.47
15	49.07	42.00

Circle Center At X = 37.2 ft.; Y = 45.2 ft. and Radius, 12.4 ft.

*** 3.179 ***

1

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	26.90	37.00
2	28.49	35.79
3	30.25	34.84
4	32.13	34.15
5	34.09	33.75
6	36.08	33.64
7	38.07	33.82
8	40.02	34.29
9	41.87	35.05
10	43.59	36.07
11	45.14	37.33
12	46.49	38.81
13	47.60	40.47
14	48.33	42.00

Circle Center At X = 35.8 ft.; Y = 47.2 ft. and Radius, 13.5 ft.

*** 3.182 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	27.93	37.00
2	29.36	35.60
3	30.99	34.44
4	32.78	33.54
5	34.68	32.94
6	36.66	32.63
7	38.66	32.63
8	40.63	32.95
9	42.54	33.56
10	44.32	34.47
11	45.94	35.63
12	47.37	37.04
13	48.56	38.65
14	49.48	40.42
15	50.01	42.00

Circle Center At X =   37.6 ft.; Y =   45.5 ft. and Radius,   12.9 ft.

***   3.183   ***

1

```
                   Y              A      X      I      S            FT

                   .00      12.50     25.00     37.50     50.00     62.50

X        .00 +---------+-------*-+-*-------*---------+---------+
             -                          ....
             -                         .....
             -                        ......
             -                        ......
             -                      ........
       12.50 +                      ........
             -                     .........
             -                     .........
             -                    ..........
             -                    ..........
             -                    ..........
A      25.00 +                   ..........1
             -                   .......7713
             -                   .......713*
             -                   ......713..
             -                    ....713...
             -                    ....713....
X      37.50 +                    ....713.....
             -                     ...713.....
             -                     ...7419.....
```

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             -                      ...7139.....
             -                      ...761399..*
             -                       ....6131889
I      50.00 +                        ....644112
             -                         .....6741
             -                          .......6
             -                            ......
             -                              ....
             -                                .*
S      62.50 +
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       75.00 +                             *
             -
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             -
F      87.50 +
             -
             -
             -
             -
             -
□     100.00 +                 *   *       *
```

ATTACHMENT B
FREESTANDING SHEET PILE FLOOD WALL ANALYSIS

S.O. No. ____

Subject: PASSAIC RIVER LONG HILL TWP FLOOD CONTROL SHEET PILE LEVEE RETAINING WALL DESIGN

Sheet No. 1a of 21

Drawing No. ____

Computed by REC Checked By JAD Date 11/07/02

Baker

NAV FAC 7.2 - 39 (page 16)

			EFF. ϕ
CL	COHESION	- 1800 PSF	28°
	SAT.	- 270 PSF	
CH	COHESION	- 2150 PSF	19°
	SAT	- 230	

CONSERVATIVELY USE $\phi = 15°$

" USE $C' = 200$ PSF SATURATED COND.

S.O. No. ____

Subject: PASSAIC RIVER LONG HILL TWP. FLOOD CONTROL - SHEET PILE RETAINING WALL

Sheet No. 1 of 21

Drawing No. ____

Computed by REC Checked By JAD Date 11/25/02

Baker

217 - 0

WATER

212 - 5

$\gamma = 130$ PCF (SAT) $C = 200$ PSF $\phi = 15°$

$\gamma = 105$ PCF (MOIST) $C = 200$ PSF $\phi = 15°$

10

202 15

$\gamma = 110$ PCF SAT, 80 PCF MOIST

$C = 200$ PSF

$\phi = 15°$

197 20

$\phi = 15°$

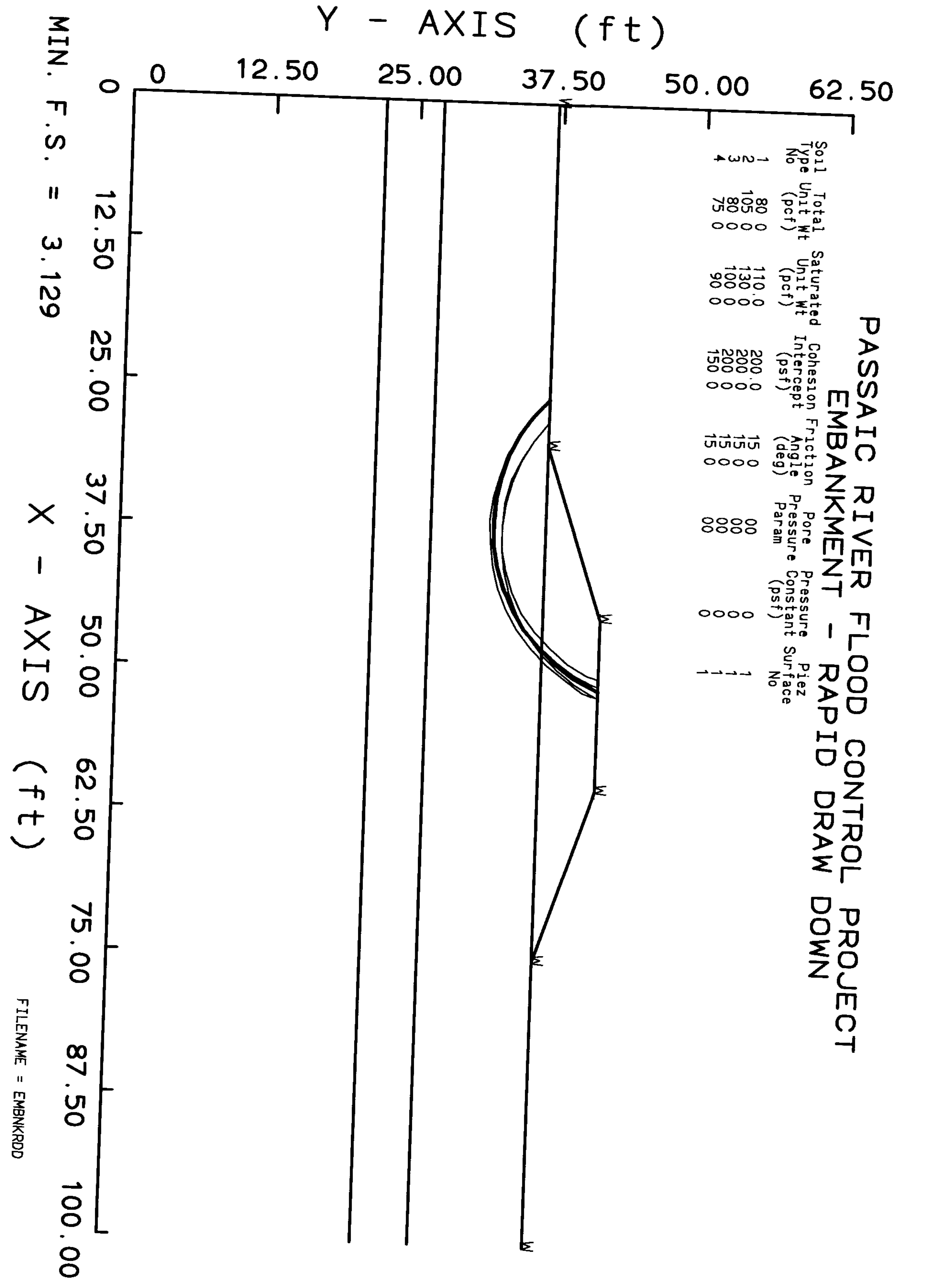
25 $C = 150°$

$\gamma_{SAT} = 90$ PCF

30

185 - 32

35



SHEET PILE DESIGN

ACCORDING TO BLUM-METHOD

Date:	4/7/2003
User-Name:	R. CLINE
Project:	PASSAIC RIVER
File-Name:	C:\ProSheet\PASSAIC RIVERFREE.spc
Comment:	

Project: PASSAIC RIVER
Section1 - Headwall

Date: 4/7/2003
File Name: C:\ProSheet\PASSAIC RIVERFREE.spc

PILE CHECK

		Depth [ft]
Chosen Sheet Pile Section	PU6	
Moment of Inertia [in4/ft]	49.209	
Section Modulus [in3/ft]	11.160	
Area [in2/ft]	4.536	
Mass [lbs/ft2]	15.361	
Steel Grade [lb/in2]	34795.866	
Minimal Moment [kipft/ft]	-0.063	10.262
Maximal Moment [kipft/ft]	2.385	7.356
Normal Forces at Min. Moment [kip/ft]	0.000	10.262
Normal Forces at Max. Moment [kip/ft]	0.000	7.356
Deflection at Min. Moment [ft]	0.000	10.262
Deflection at Max. Moment [ft]	-0.001	7.356
Min. Stress at Min. Moment [lb/in2]	-67.841	10.262
Max. Stress at Min. Moment [lb/in2]	67.841	10.262
Min. Stress at Max. Moment [lb/in2]	-2564.507	7.356
Max. Stress at Max. Moment [lb/in2]	2564.507	7.356
Safety > Req. Safety = 2.000	13.568	
Pile Top [ft]		0.000
Pile Tip [ft]		10.760
Vertical Equilibrium [kip/ft]	0.000	
Anchor Force (horiz.) [kip/ft]	0.000	0.000

Project: PASSAIC RIVER
Section1 - Headwall

Date: 4/7/2003
File Name: C:\ProSheet\PASSAIC RIVERFREE.spc

PILE SECTION

Name	PU6 ← Steel Piling used in Calculation (See page 18 for Vinyl)
Inertia [in4/ft]	49.209
Modulus [in3/ft]	11.160
Area [in2/ft]	4.536
Mass [lbs/ft2]	15.361
Steelgrade [lb/in2]	34795.866
Requested Safety	2.000

EXTREMAL VALUES

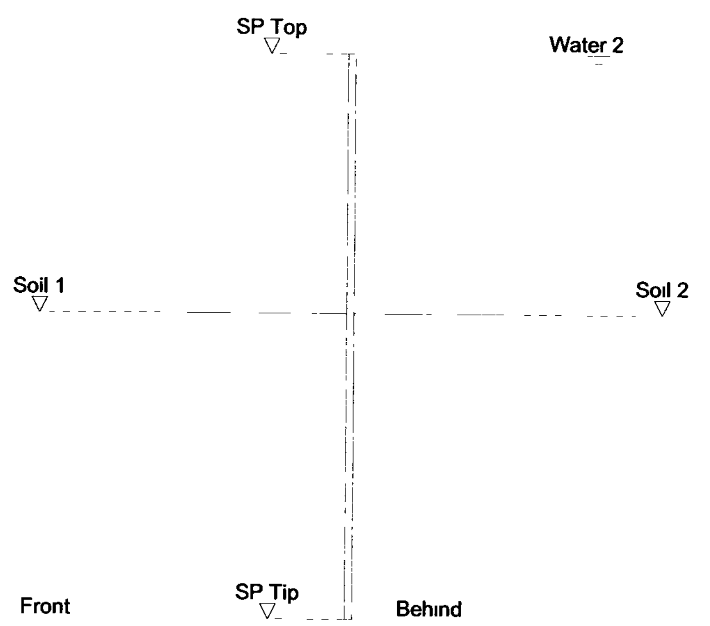
	z Min [ft]	Min	z Max [ft]	Max
Deflection [ft]	0.000	-0.008	10.230	0.000
Cross Force [kip/ft]	10.230	-1.778	5.000	0.795
Moment [kipft/ft]	10.262	-0.063	7.356	2.385

Project: PASSAIC RIVER
Section1 - Headwall

Date: 4/7/2003
File Name: C:\ProSheet\PASSAIC RIVERFREE.spc

GEODATA

Sheet Pile Top Level [ft]	0.000
Sheet Pile Tip Level [ft]	10.760
Soil Level in Front [ft]	5.000
Soil Level behind [ft]	5.000
Anchorlevel [ft]	0.000
Water Level in Front [ft]	15.000
Water Level behind [ft]	0.000
Soil Surface Inclination in Front [Deg]	0.000
Soil Surface Inclination behind [Deg]	0.000
Caquot Surcharge in Front [kip/ft2]	0.000
Caquot Surcharge behind [kip/ft2]	0.000
Anchor Inclination [Deg]	0.000
Earth Support	Cantilever



LAYERS IN FRONT

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kph	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	15.000	0.105	0.130	1.700	15.000	0.000	0.200
Layer 2	20.000	0.080	0.110	1.700	15.000	0.000	0.200
Layer 3	32.000	0.075	0.090	1.700	15.000	0.000	0.150

LAYERS BEHIND

	Layer Tip [ft]	Density Moist [kip/ft3]	Density Submerged [kip/ft3]	Kah	Phi [Deg]	Delta [Deg]	Cohesion [kip/ft2]
Layer 1	15.000	0.105	0.130	0.589	15.000	0.000	0.200
Layer 2	20.000	0.080	0.110	0.589	15.000	0.000	0.200
Layer 3	32.000	0.075	0.090	0.589	15.000	0.000	0.150

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page 1b.

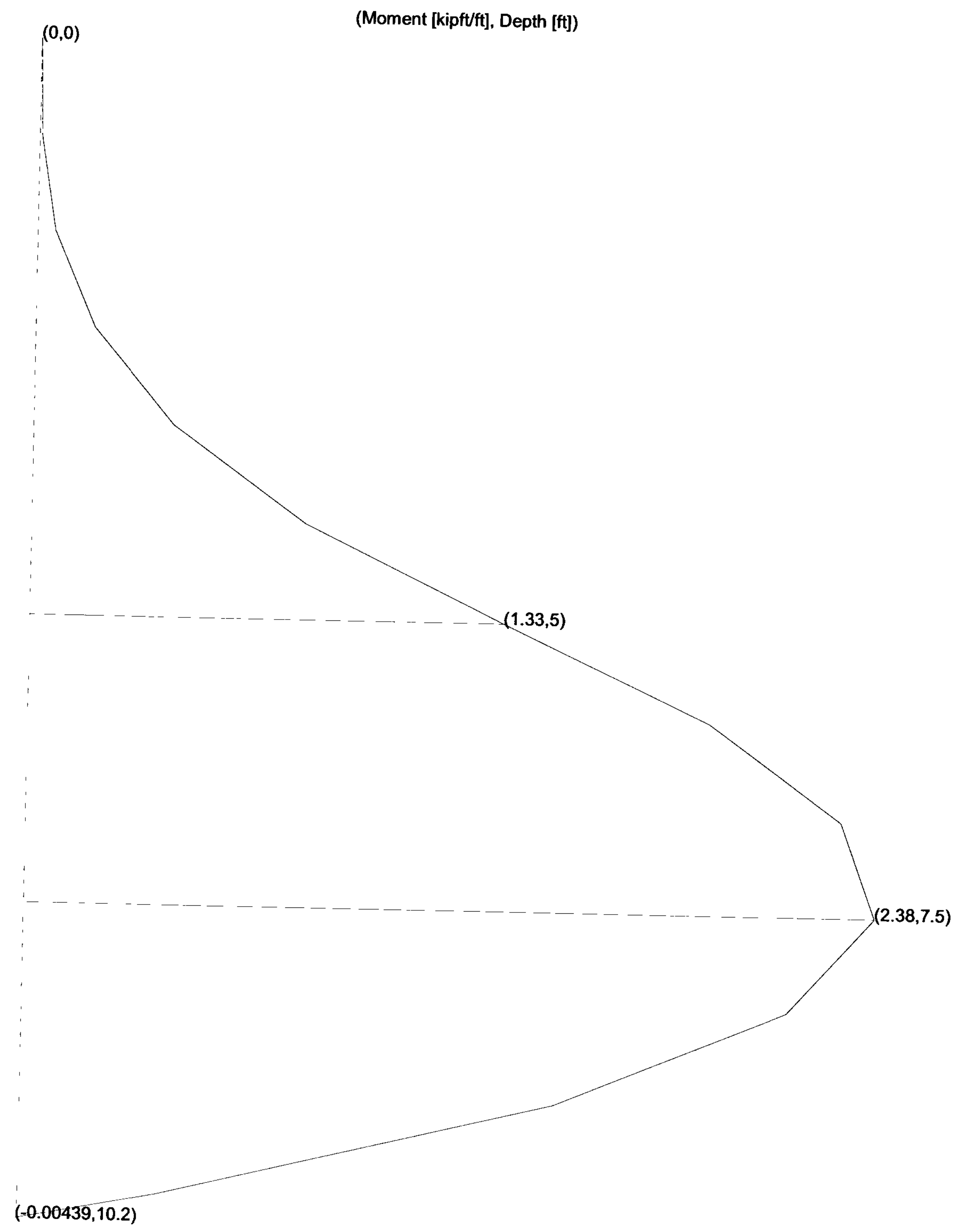
TABLE 1
Typical Properties of Compacted Soils

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression: At 1.4 tsf (20 psi)	Typical Value of Compression: At 3.6 tsf (50 psi)	Typical Strength Characteristics: Cohesion (as compacted) psf	Cohesion (saturated) psf	ø (Effective Stress Envelope Degrees)	Tan ø	Typical Coefficient of Permeability ft./min.	Range of CBR Values	Range of Subgrade Modulus k lbs/cu in.
				Percent of Original Height								
GW	Well graded clean gravels, gravel-sand mixtures.	125 - 135	11 - 8	0.3	0.6	0	0	>38	>0.79	5×10^{-2}	40 - 80	300 - 500
GP	Poorly graded clean gravels, gravel-sand mix	115 - 125	14 - 11	0.4	0.9	0	0	>37	>0.74	10^{-1}	30 - 60	250 - 400
GM	Silty gravels, poorly graded gravel-sand-silt.	120 - 135	12 - 8	0.5	1.1	.....	.....	>34	>0.67	$>10^{-6}$	20 - 60	100 - 400
GC	Clayey gravels, poorly graded gravel-sand-clay.	115 - 130	14 - 9	0.7	1.6	.....	.....	>31	>0.60	$>10^{-7}$	20 - 40	100 - 300
SW	Well graded clean sands, gravelly sands.	110 - 130	16 - 9	0.6	1.2	0	0	38	0.79	$>10^{-3}$	20 - 40	200 - 300
SP	Poorly graded clean sands, sand-gravel mix.	100 - 120	21 - 12	0.8	1.4	0	0	37	0.74	$>10^{-3}$	10 - 40	200 - 300
SM	Silty sands, poorly graded sand-silt mix.	110 - 125	16 - 11	0.8	1.6	1050	420	34	0.67	$5 \times >10^{-5}$	10 - 40	100 - 300
SM-SC	Sand-silt clay mix with slightly plastic fines.	110 - 130	15 - 11	0.8	1.4	1050	300	33	0.66	$2 \times >10^{-6}$	5 - 30	100 - 300
SC	Clayey sands, poorly graded sand-clay-mix.	105 - 125	19 - 11	1.1	2.2	1550	230	31	0.60	$5 \times >10^{-7}$	5 - 20	100 - 300
ML	Inorganic silts and clayey silts.	95 - 120	24 - 12	0.9	1.7	1400	190	32	0.62	$>10^{-5}$	15 or less	100 - 200
ML-CL	Mixture of inorganic silt and clay.	100 - 120	22 - 12	1.0	2.2	1350	460	32	0.62	$5 \times >10^{-7}$	.....	
CL	Inorganic clays of low to medium plasticity.	95 - 120	24 - 12	1.3	2.5	1800	270	28	0.54	$>10^{-7}$	15 or less	50 - 200
OL	Organic silts and silt-clays, low plasticity.	80 - 100	33 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	50 - 100
MH	Inorganic clayey silts, elastic silts.	70 - 95	40 - 24	2.0	3.8	1500	420	25	0.47	$5 \times >10^{-7}$	10 or less	50 - 100
CH	Inorganic clays of high plasticity	75 - 105	36 - 19	2.6	3.9	2150	230	19	0.35	$>10^{-7}$	15 or less	50 - 150
OH	Organic clays and silty clays	65 - 100	45 - 21	.....	.....	.....	.....	.....	.....	.....	5 or less	25 - 100

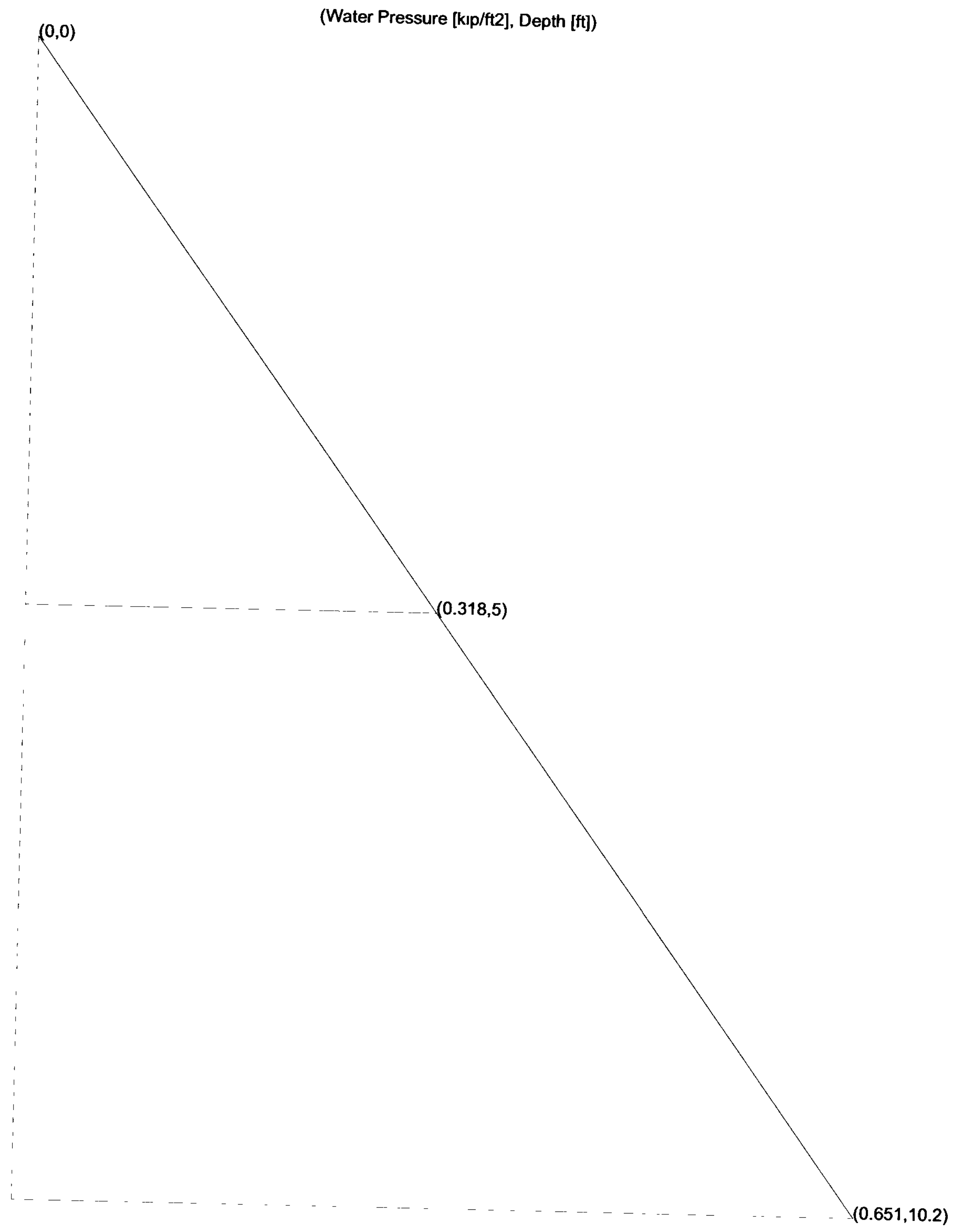
Notes:

1. All properties are for condition of "Standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical stength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement.
4. (>) indicates that typical property is greater than the value shown.
(..) indicates insufficient data available for an estimate.

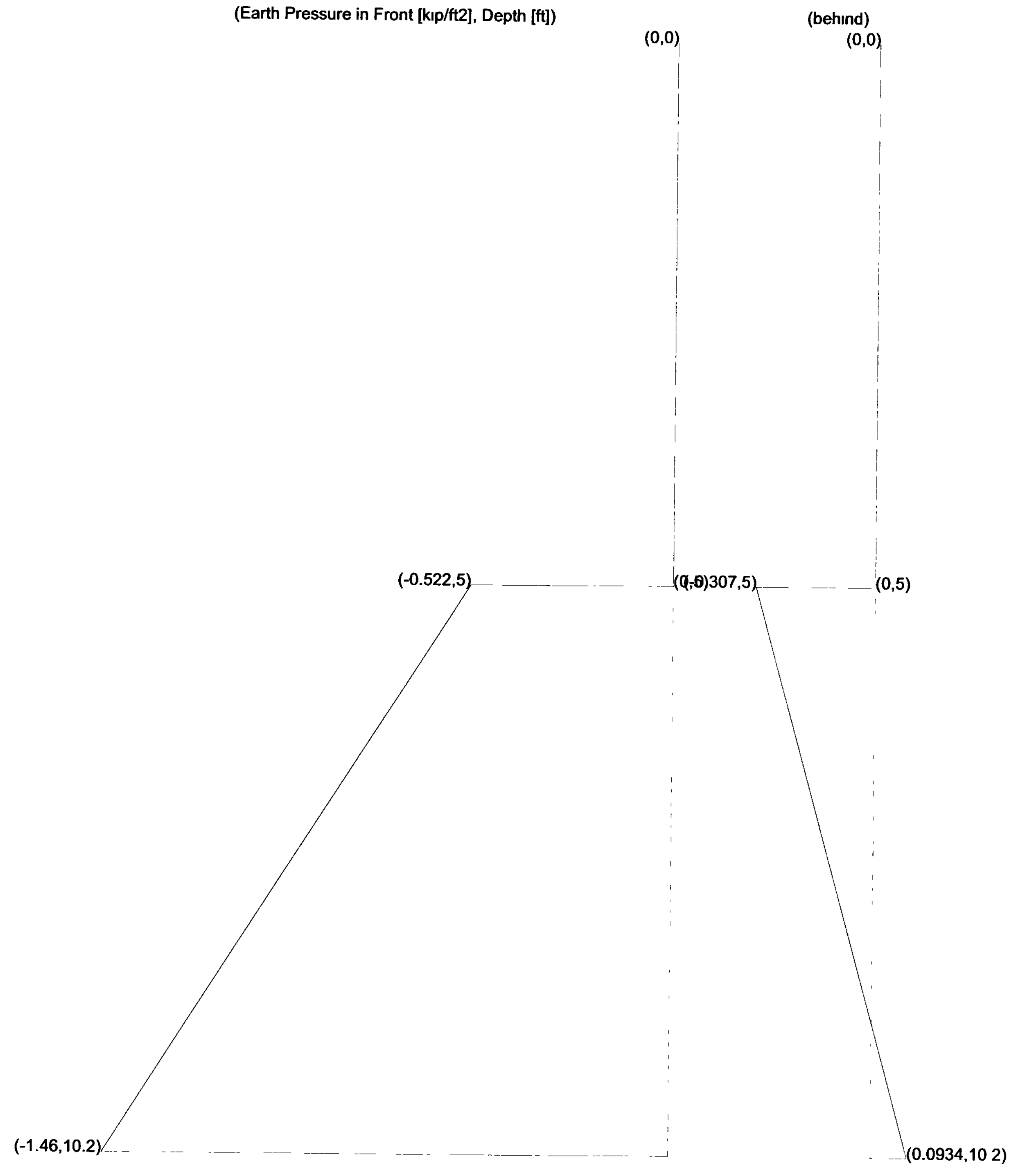
MOMENT DIAGRAM



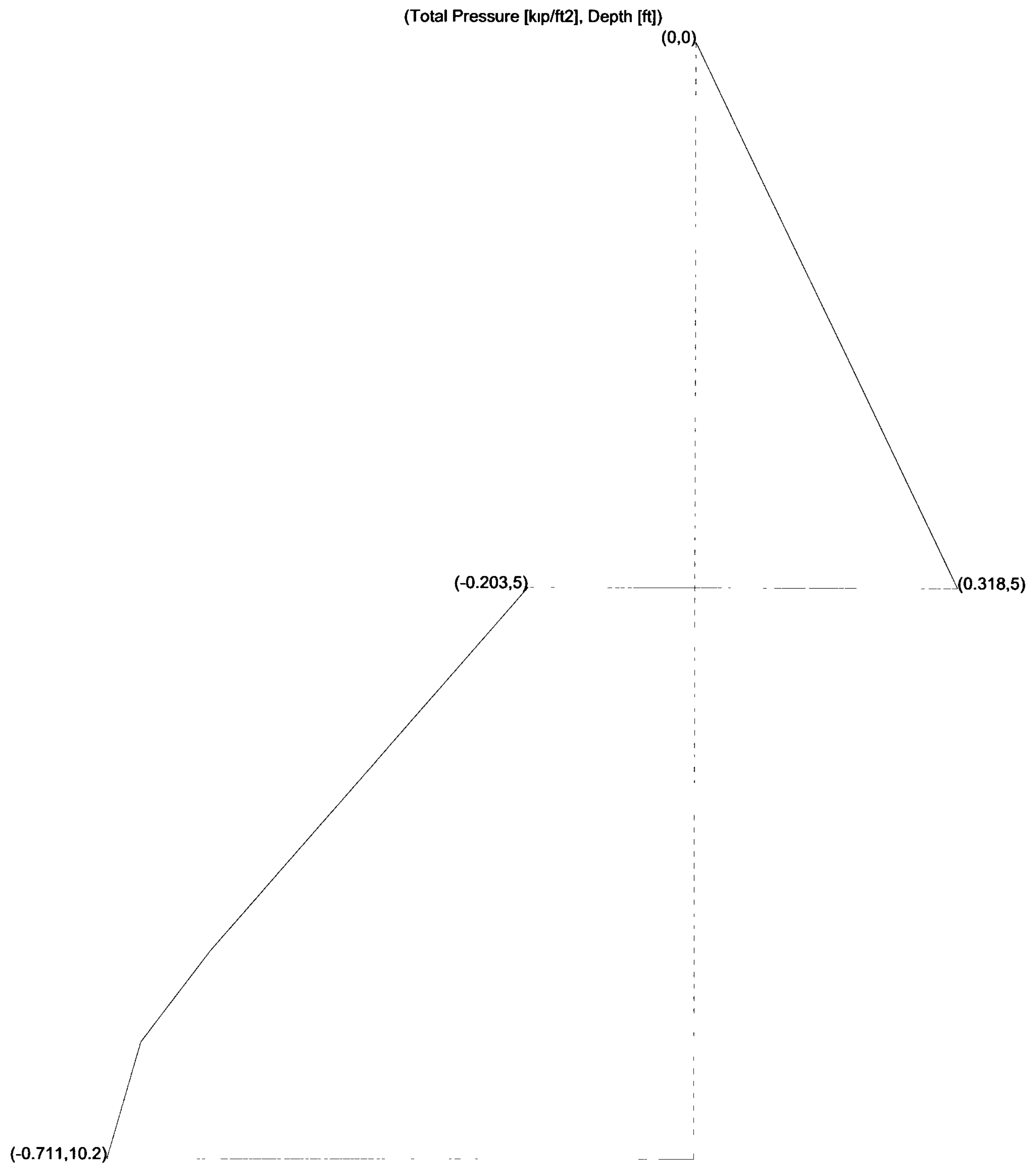
WATER PRESSURE DIAGRAM



EARTH PRESSURE DIAGRAM



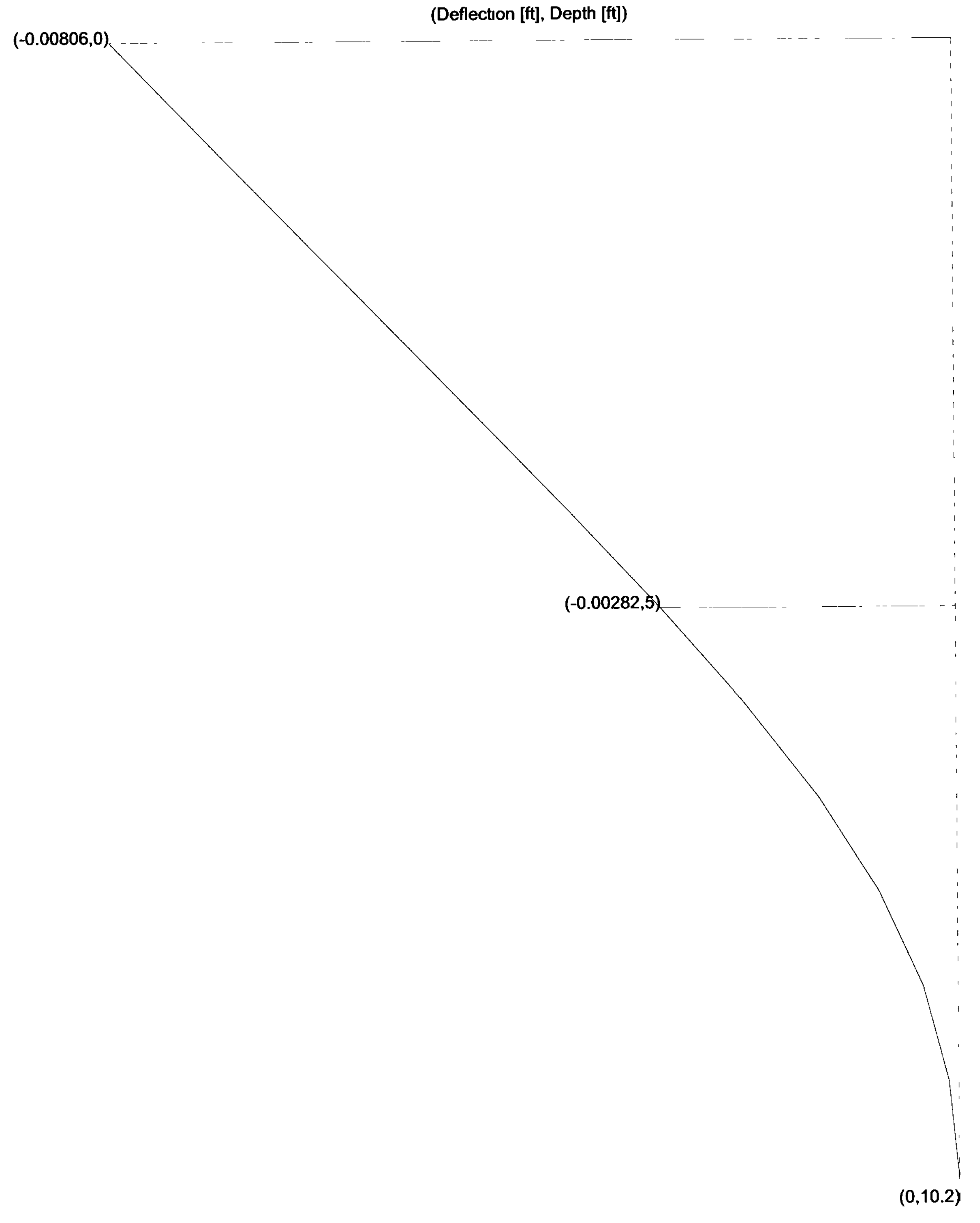
TOTAL PRESSURE DIAGRAM



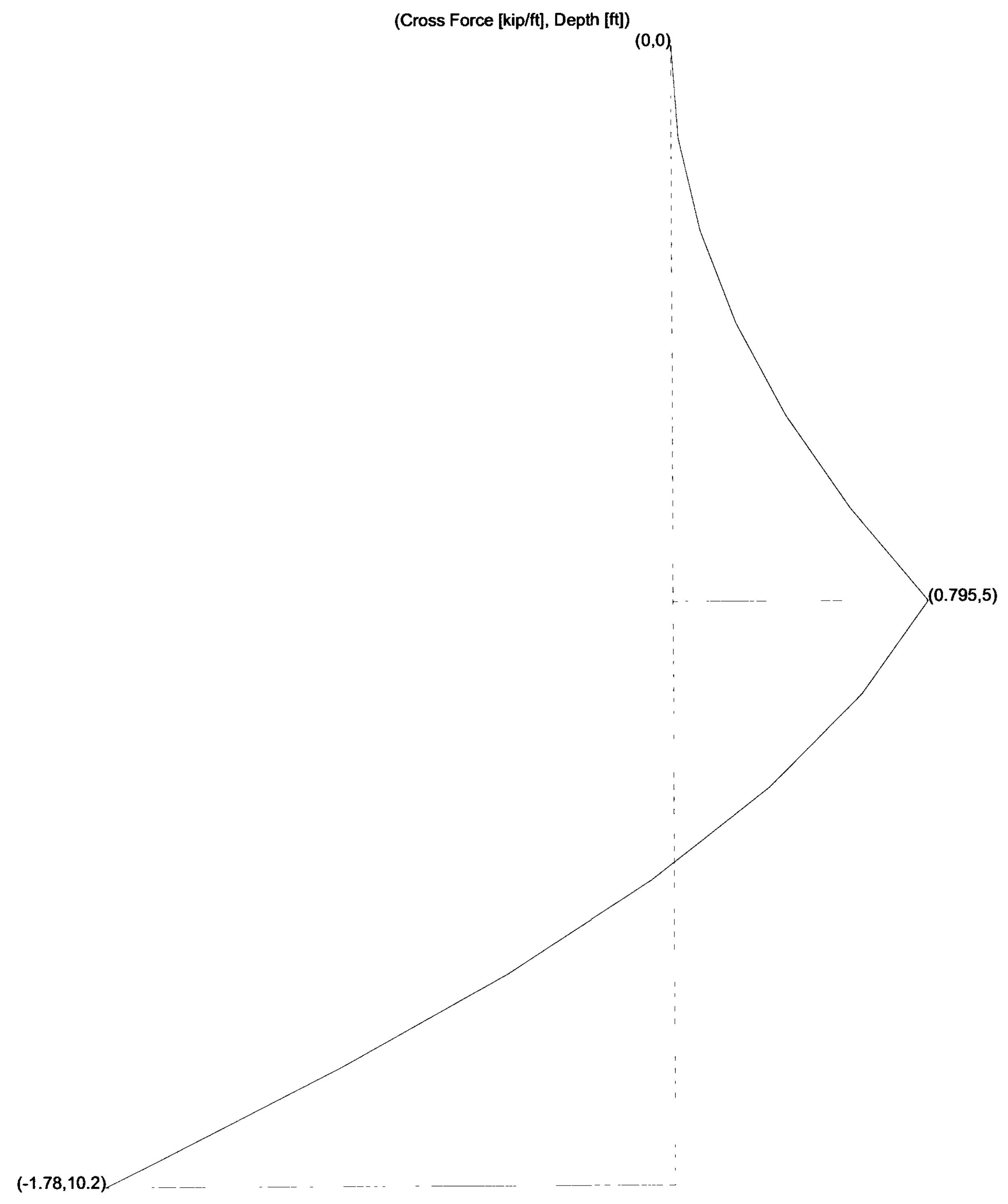
ALL VALUES

Depth [ft]	Deflection [ft]	Rotation [Rad]	Cross Force [kip/ft]	Moment [kipft/ft]	Total Pressure [kip/ft2]	Earth Pressure in Front [kip/ft2]	behind [kip/ft2]	Water Pressure [kip/ft2]	Userdefined Pressure [kip/ft2]
0.000	-0.008	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.833	-0.007	-0.001	0.022	0.006	0.053	0.000	0.000	0.053	0.000
0.833	-0.007	-0.001	0.022	0.006	0.053	0.000	0.000	0.053	0.000
1.667	-0.006	-0.001	0.088	0.049	0.106	0.000	0.000	0.106	0.000
1.667	-0.006	-0.001	0.088	0.049	0.106	0.000	0.000	0.106	0.000
2.500	-0.005	-0.001	0.199	0.166	0.159	0.000	0.000	0.159	0.000
2.500	-0.005	-0.001	0.199	0.166	0.159	0.000	0.000	0.159	0.000
3.333	-0.005	-0.001	0.354	0.393	0.212	0.000	0.000	0.212	0.000
3.333	-0.005	-0.001	0.354	0.393	0.212	0.000	0.000	0.212	0.000
4.167	-0.004	-0.001	0.552	0.767	0.265	0.000	0.000	0.265	0.000
4.167	-0.004	-0.001	0.552	0.767	0.265	0.000	0.000	0.265	0.000
5.000	-0.003	-0.001	0.795	1.326	0.318	0.000	0.000	0.318	0.000
5.000	-0.003	-0.001	0.795	1.326	-0.203	-0.522	-0.307	0.318	0.000
5.833	-0.002	-0.001	0.586	1.907	-0.299	-0.670	-0.243	0.371	0.000
5.833	-0.002	-0.001	0.586	1.907	-0.299	-0.670	-0.243	0.371	0.000
6.667	-0.001	-0.001	0.297	2.280	-0.395	-0.819	-0.179	0.424	0.000
6.667	-0.001	-0.001	0.297	2.280	-0.395	-0.819	-0.179	0.424	0.000
7.500	-0.001	-0.000	-0.072	2.380	-0.491	-0.968	-0.116	0.477	0.000
7.500	-0.001	-0.000	-0.072	2.380	-0.491	-0.968	-0.116	0.477	0.000
8.333	-0.000	-0.000	-0.521	2.138	-0.586	-1.117	-0.052	0.530	0.000
8.333	-0.000	-0.000	-0.521	2.138	-0.586	-1.117	-0.052	0.530	0.000
9.167	0.000	0.000	-1.044	1.491	-0.670	-1.265	0.012	0.583	0.000
9.167	0.000	0.000	-1.044	1.491	-0.670	-1.265	0.012	0.583	0.000
10.000	0.000	0.000	-1.616	0.385	-0.702	-1.414	0.076	0.636	0.000
10.000	0.000	0.000	-1.616	0.385	-0.702	-1.414	0.076	0.636	0.000
10.230	0.000	0.000	-1.778	-0.004	-0.711	-1.455	0.093	0.651	0.000

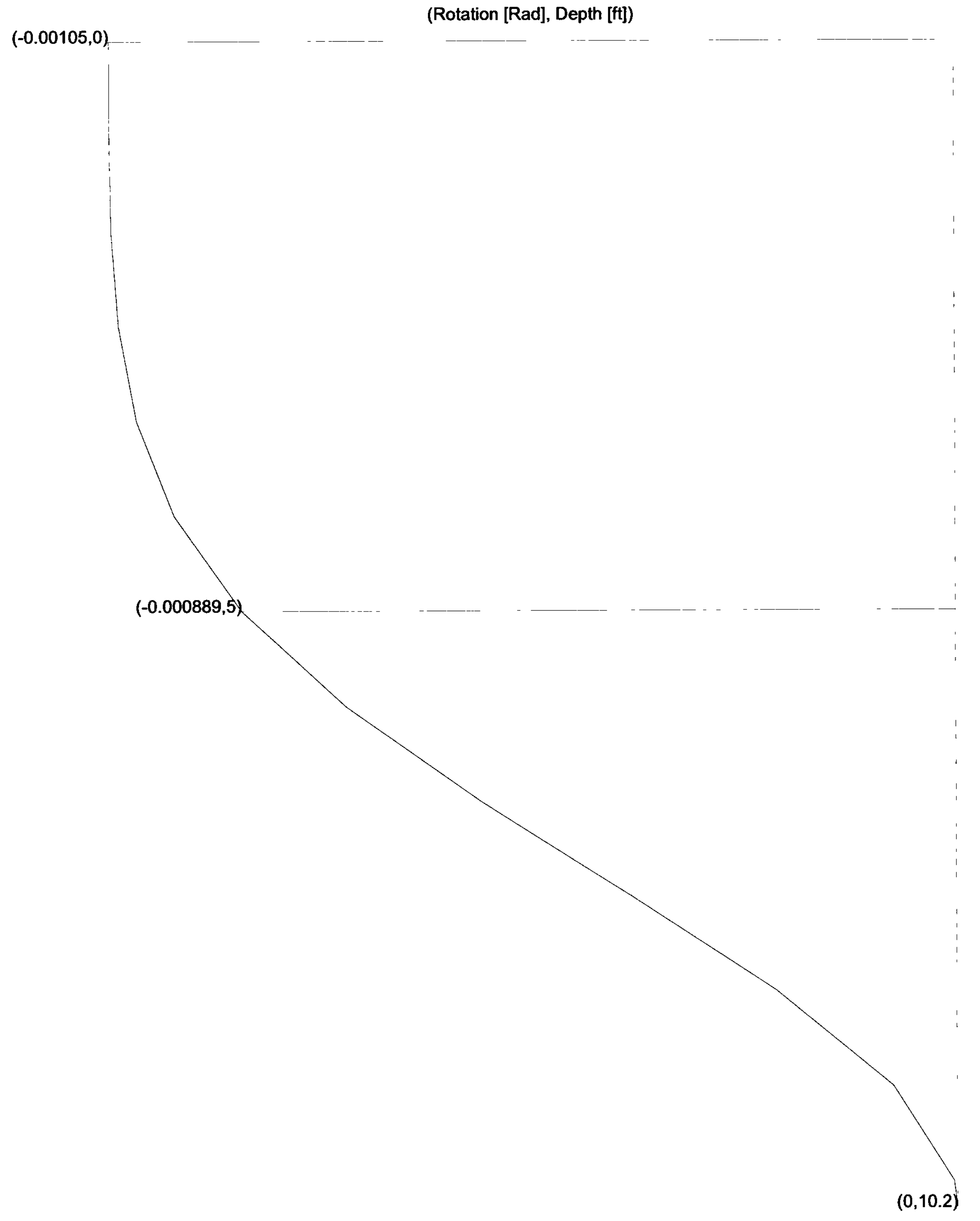
DEFLECTION DIAGRAM



CROSS FORCE DIAGRAM



ROTATION DIAGRAM



$EI = 380,000$ lb/in

page 16 of 21

Characteristic	Units	ShoreGuard 950	ShoreGuard 700	ShoreGuard 550	ShoreGuard 425	ShoreGuard 400	ShoreGuard 300	ShoreGuard 225
Strength Rating	FT.LBS./LINEAR FT.	13,179	10,667	6,000	4,133	3,778	2,889	1,975
Weight / Foot	LBS.	9.8	8	5.4	3.65	3.8	3.2	2.8
Nominal Thickness	IN.	0.650	0.450	0.400	0.280	0.290	0.250	0.225
Section Modulus	IN.^{3}/LINEAR FT.	59	40	22.5	15.5	17	13	7.4
Modulus of Elasticity ASTM D-790	LBS./IN.^{2}	380,000	380,000	380,000	380,000	380,000	380,000	380,000
Tensile Strength ASTM D-638	LBS./IN.^{2}	6,300	6,300	6,300	6,300	6,300	6,300	6,300
ShoreGuard Design Strength	LBS./IN.^{2}	2,667	3,200	3,200	3,200	2,667	2,667	3,200
Impact Strength ASTM D-4226	IN.-LBS./IN.^{2}	17,500	15,000	15,000	13,750	13,750	13,750	11,000
Section Depth	IN.	11.75	10	8	8	8	7	5
Section Width	IN.	18	12	12	24	12	12	18
Transmissivity	CM/SECOND FOR SW SOILS	8×10^{-6}	4.15×10^{-6}	4.15×10^{-6}	1.35×10^{-6}	2.7×10^{-6}	2.7×10^{-6}	1.67×10^{-6}
I (Calc)	$IN^4/12IN$	347						

Standard Color	N/A	GREY	GREY	GREY CLAY	GREY CLAY	GREY CLAY	GREY CLAY	GREY CLAY
Custom Colors	N/A	CLAY	CLAY	BROWN SANDSTONE	BROWN SANDSTONE	BROWN SANDSTONE	BROWN SANDSTONE	SANDSTONE
Standard Inventory Lengths	FT.	N/A	N/A	14, 16	12, 14, 16	12, 14, 16	8, 10, 12	6, 8, 10
Standard Packaging	SHEETS/BUNDLE	6	12	20	18	20	20	20
I-Beam Lock™	N/A	YES	YES	YES	YES	YES	YES	YES
UV Protection	N/A	YES	YES	YES	YES	YES	YES	YES
Strong Back Ribs™	N/A	YES	YES	YES	YES	NO	NO	YES

Physical properties are defined by ASTM Test Standards for Plastic Building Products. The values shown are nominal and may vary. The information found in this document is believed to be true and accurate. No warranties of any kind are made as to the suitability of ShoreGuard for particular applications or the results obtained therefrom. ShoreGuard® is a registered trademark of Materials International, Inc. United States Patent Numbers 5,145,287; 5,881,508; 6,000,883; 6,033,155; 6,053,666; D420,154. Other patents pending.

Geoguard

ShoreGuard Specifications Chart 052002.doc 5/20/02 3:08 PM

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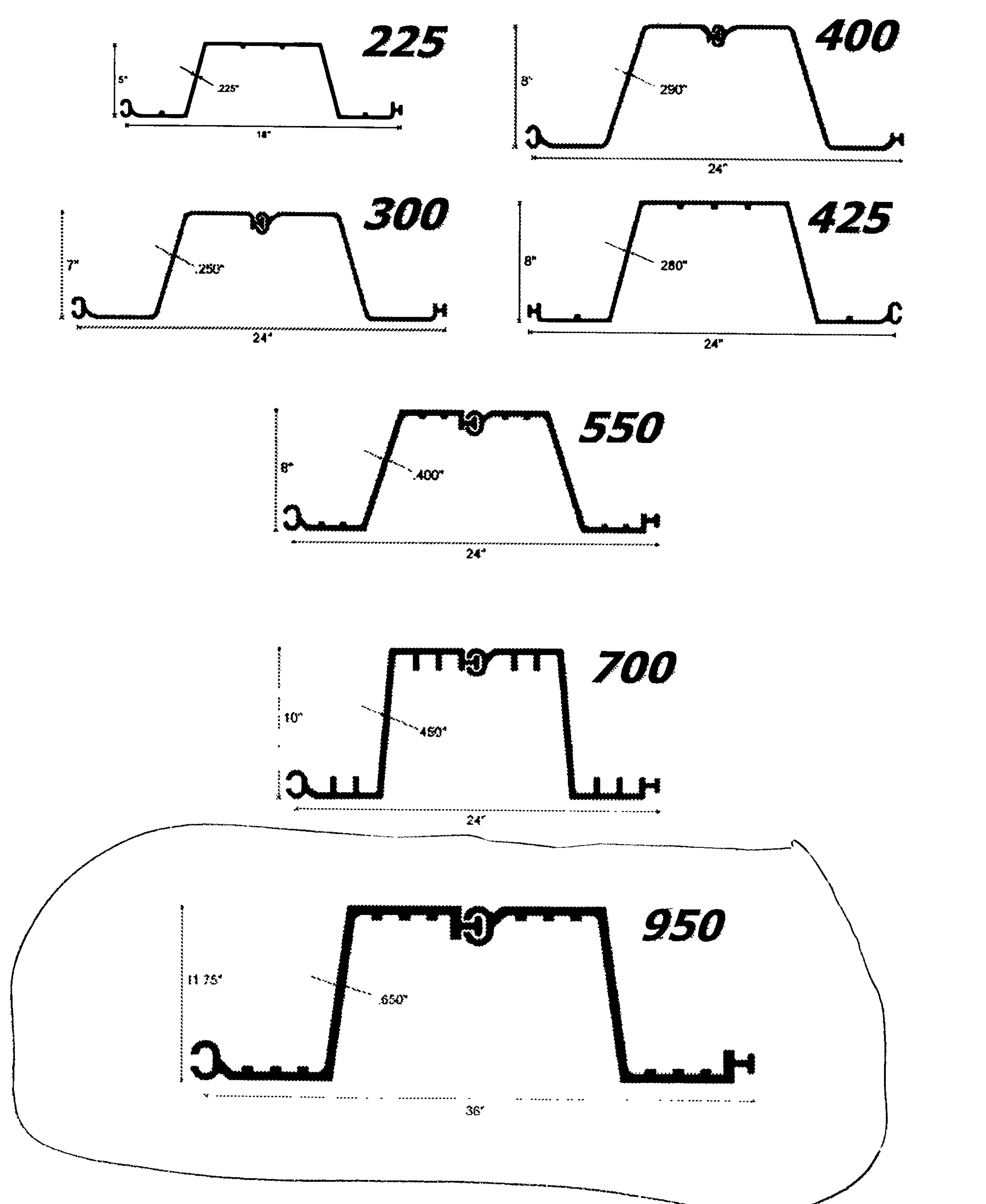
ShoreGuard® Profiles



S.O. No. 24421

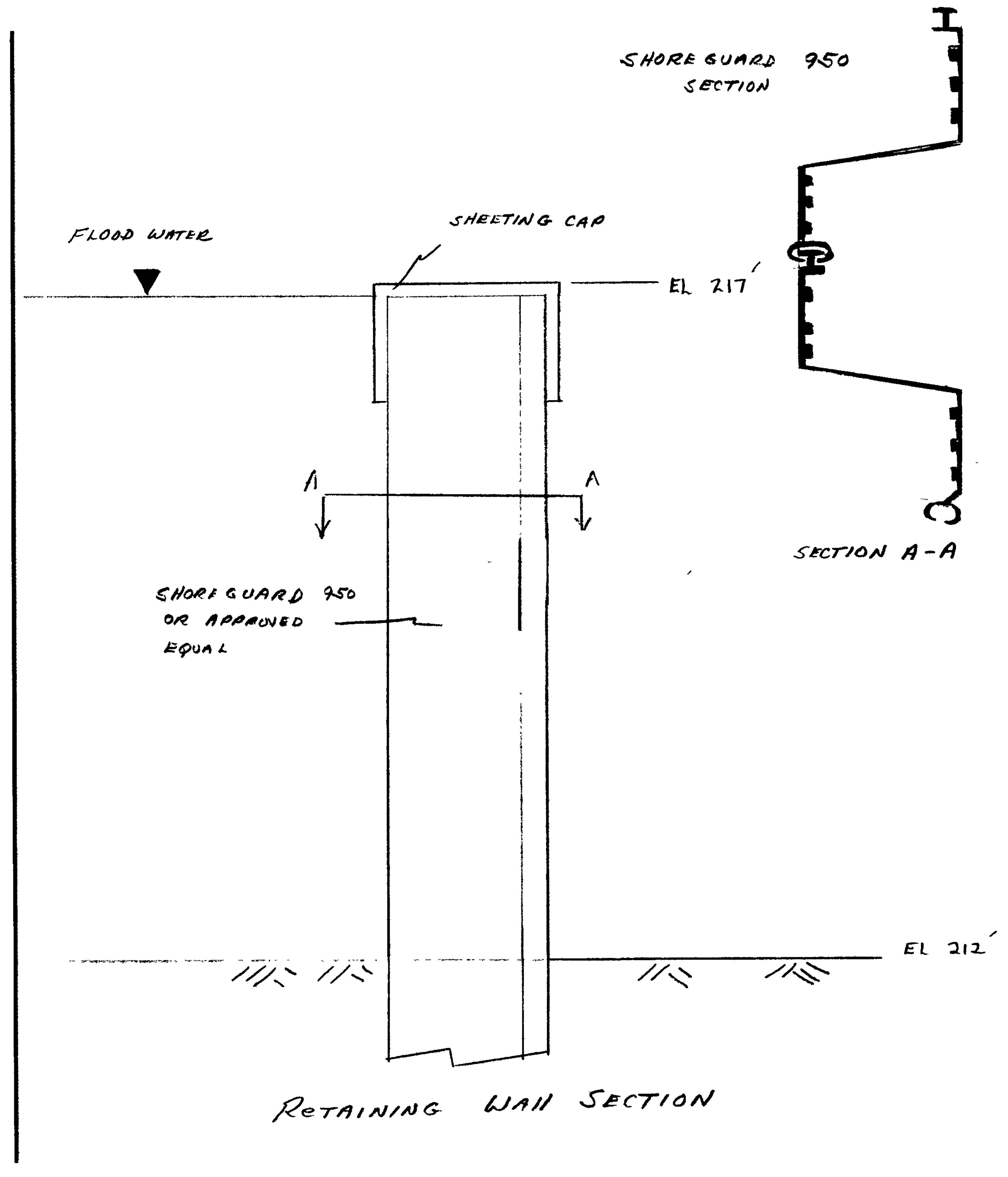
Subject LONG HILL TOWNSHIP FLOOD CONTROL PROJECT – Floodwall

Sheet No 14 of 21

Drawing No.

Computed by REC Checked By JAD Date 11/25/02

Baker



Project: PASSAIC RIVER
Section1 - Headwall

Date: 4/7/2003
File Name: C:\ProSheet\PASSAIC RIVERFREE.spc

ALL BOUSSINESQ VALUES

Depth [ft]
0.000
0.833
0.833
1.667
1.667
2.500
2.500
3.333
3.333
4.167
4.167
5.000
5.000
5.833
5.833
6.667
6.667
7.500
7.500
8.333
8.333
9.167
9.167
10.000
10.000
10.230

S.O. No 24421

Subject LONG HILL TWP FLOOD CONTROL
Floodwall

Sheet No. 20 of 21

Drawing No

Computed by REC Checked By JW Date 11/27/02

Baker

SEALANT MATERIAL RECOMMENDED FOR VINYL SHEETING JOINTS

ADEKA – SOLD BY UNIQUE TECHNIQUES
1-800-689-1722

THIS IS TROWELLED ONTO SHEETS 10 HRS BEFORE INSTALLATION. IT CURES AND ADHERES TIGHTLY TO VINYL AFTER DRIVING THE SHEETS AND UPON CONTACT WITH WATER THIS HYDROPHYLLIC MATERIAL EXPANDS TO SEVERAL TIMES ITS ORIGINAL VOLUME FILLING THE JOINTS RESULTING IN A WATER TIGHT SEAL.

(See page 21 for catalog cut)

S.O. No. 24421

Subject: PASSAIC RIVER LONG HILL TWP. FLOOD CONTROL –
RETAINING WALL DESIGN

Sheet No. 19 of 21

Drawing No.

Computed by REC Checked By JW Date 11/25/02

Baker

RECOMMEND

SHORE GUARD 950 AS MANUFACTURED BY MATERIALS INTERNATIONAL OR APPROVED EQUAL. ($S = 59\ in^3/FT$)
$Y = 5.875''$
EMBEDDED TO 12' BELOW GRADE (217 msl) $I = 347\ in^4$

NO ANCHORS ARE REQUIRED IF 1.04" OF DEFLECTION @ TOP CAN BE TOLERATED.

COVER WITH CAP AS RECOMMENDED BY MANUFACTURER

INSTALL IN ACCORDANCE WITH ALL MANUFACTURER'S REQUIREMENTS.

S.O. No 24421

Subject: PASSAIC RIVER LONG HILL TWP FLOOD CONTROL
RETAINING WALL DESIGN

Sheet No. 18 of 21

Drawing No

Computed by REC Checked By JW Date 11/25/02

Baker

DEFLECTION OF VINYL SHEET

STIFFNESS OF PU6 STEEL SHEET = EI

$EI = 49.21\ in^4\ (29{,}000\ KSI)$

$= 1{,}427{,}090\ K \cdot in^2$

FOR STIFFNESS OF VINYL SHEET, EI

$= 380{,}000\ PSI\ (347\ in^4)$

$= 131{,}860\ K \cdot in^2$

$\therefore \quad \dfrac{EI_{PU6}}{EI_{SG}} = \dfrac{1{,}427{,}090\ K \cdot in^2}{131{,}860\ K \cdot in^2} = 10.82$

∴ THE DEFLECTION OF THE VINYL SHEET WOULD BE 10.82 TIMES THE DEFLECTION OF THE STEEL SHEET.

Deflection of PU6 Sheet (From ProSheet) = 0.008'

∴ Deflect. of Shoreguard 950 = 10.82(0.008')

= 1.04"

w/o TIE BACK.

MAX MOMENT = 2.38 'K/FT or 2,380 'lb/FT

SHOREGUARD 950 STRENGTH RATING = 13,179 'lb/FT

2,380 'lb/FT < 13,179 'lb/FT ∴ OK

S.O. No.

Subject: PASSAIC RIVER – SHEET PILE WALL
CALC OF MOMENT OF INERTIA

Sheet No. 17 of 21

Drawing No.

Computed by REC Checked By JW Date 11-25-02

Baker

SHOREGUARD 950

SECTION MODULUS, $S = \dfrac{I}{C}$

$S = 59\ in^3$

$\therefore\ I = SC$

$= 59\ in^3\ (5.875'')$

$= 347\ in^4$

I = MOMENT OF INERTIA

C = DISTANCE TO EXTREME FIBER
= 1/2 DEPTH
$= \dfrac{11.75''}{2} = 5.875''$

ATTACHMENT C
FOUNDATION CALCULATIONS
SEEPAGE CALCULATIONS

"This may seem like a small savings, but it represents a significant beginning, since the majority of flood control projects require seepage cut-offs," Bivona said.

The vinyl sheet pilings are made of modified polyvinyl chloride, a plastic that can be placed in the same environments as steel, said Peter Manning of Materials International in Atlanta, the company that won the bid on the first NOD project using vinyl sheets. And vinyl, unlike steel, does not corrode when exposed to the elements, said Manning.

"Salt, water, sunlight…all these things take a toll on steel," Manning said. "Vinyl will outlast steel every day of the week and taxpayers get to save a tremendous amount of money as a result."

Yet, despite the advantages of vinyl, it is not expected to replace steel completely.

"Vinyl is a cost-effective alternative to steel, but it is not a one-to-one substitute because it depends on the application," said Bivona. "It is only a definite replacement in appropriate seepage cut-offs."

Vinyl's only real disadvantage is that it is not as strong as steel, which means that it can not be used in applications that require steel's ability to withstand extreme weight, said Wright.

Manning agrees. "Vinyl is never going to replace steel. It's an alternative. Steel has structure and strength that vinyl doesn't. You're not going to build the Superdome on top of vinyl."

The key to the future of vinyl sheet piling in Corps projects will come by using it selectively. Bivona said about a dozen new SELA seepage projects will use vinyl sheet pilings, and that further applications are being explored. These applications might include flood walls and, possibly, in slope stabilization and channel lining projects.

Many of the benefits that may come from the use of vinyl are yet to be discovered, but one thing is certain -- the Corps will continue to save money as the use of vinyl as an alternative to steel grows.

END

Back to contents

Next story

Back to contents

Vinyl replacing some steel sheet pilings

By Maurice Ruffin
New Orleans District

Since the U.S. Army Corps of Engineers first drove sheet piling decades ago, steel has been the material of choice. Now, New Orleans District (NOD) has pioneered the use of vinyl sheet piling to replace steel in some cases. New projects using the vinyl sheets in seepage cut-off walls are expected to net a myriad of benefits for the Corps in the near future.

"It's a never-ending accumulation of savings for the Corps and our cost-sharing partners, and it's here to stay," said John Bivona, Chief of Cost Engineering Branch. He said that the money-saving uses of the vinyl sheet pilings might still be unknown, if it were not for the insight of Wade Wright, a technician in civil engineering.

"The credit belongs to Wade for having the initiative to organize the value engineering study on vinyl sheet piling," Bivona said.

Wright came up with the idea in late 1997 as he searched for an alternative to cold-rolled steel, which tended to allow some seepage.

"I wanted something with more water-tight integrity," said Wright, who then began to investigate the possibility of using vinyl. One reason it would prove to be a good alternative is because it featured an I-beam locking system, which resists separation once placed in the ground and provides a tighter seal against water seepage.

In January 1998, Wright initiated the study and wrote specifications on the properties of vinyl sheet pilings. Word spread and he began receiving calls from engineers at other Corps districts who were interested in using vinyl in their projects.

Private industry has been using the material in non-seepage projects for a few years, Bivona said, but that to his knowledge NOD is the first Corps district to design projects that specify vinyl as the sheet material.

The vinyl sheet pilings save the Corps 30 to 50 percent compared with steel, for at least three reasons. First, the steel sheet piling that NOD uses costs between \$10 and \$12 per square foot, vinyl costs only \$4.50 to \$7.50. Second, vinyl sheet pile is lighter than steel. Steel weighs between 20 and 22 pounds per square foot, while vinyl weighs from three-and-a-half to five pounds. This means lower transportation costs since more vinyl sheets can be loaded on each delivery truck. Also, steel sheets require heavy lifting equipment, while workers can carry vinyl sheets. Third, lighter installation equipment (vibratory hammers and impact hammers) can be used, resulting in even more savings.

Engineering Division has specified vinyl sheet use on five projects that are under construction. It has already been placed in the ground in a Southeast Louisiana Drainage Control Project at the Woodmere-Sunnymeade. The accumulated savings for these projects will total about \$100,000.

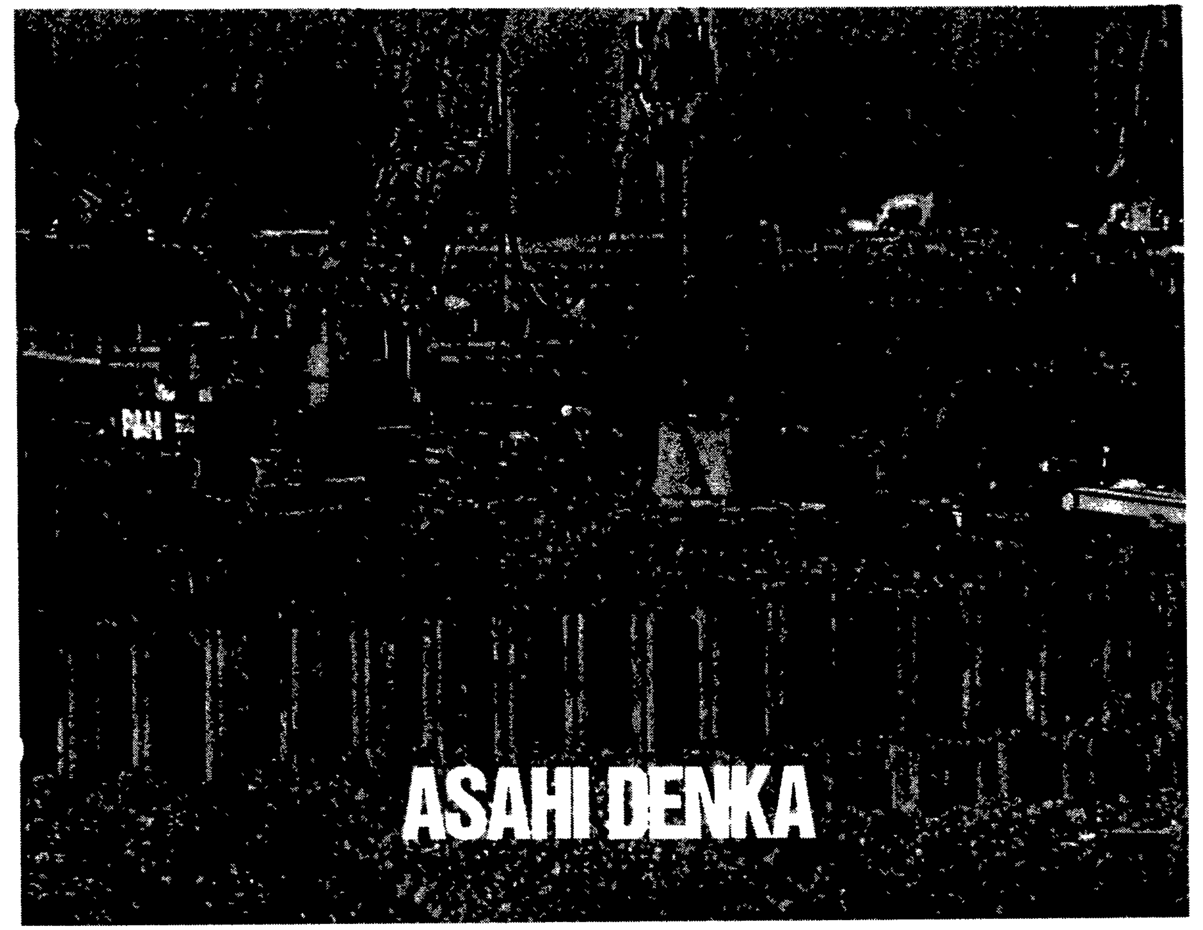
[redacted]

TECHNICAL INFORMATION CALL UNIQUE TECHNIQUES 1-800-689-1722

WATERSTOP FOR STEEL OR PVC PILES

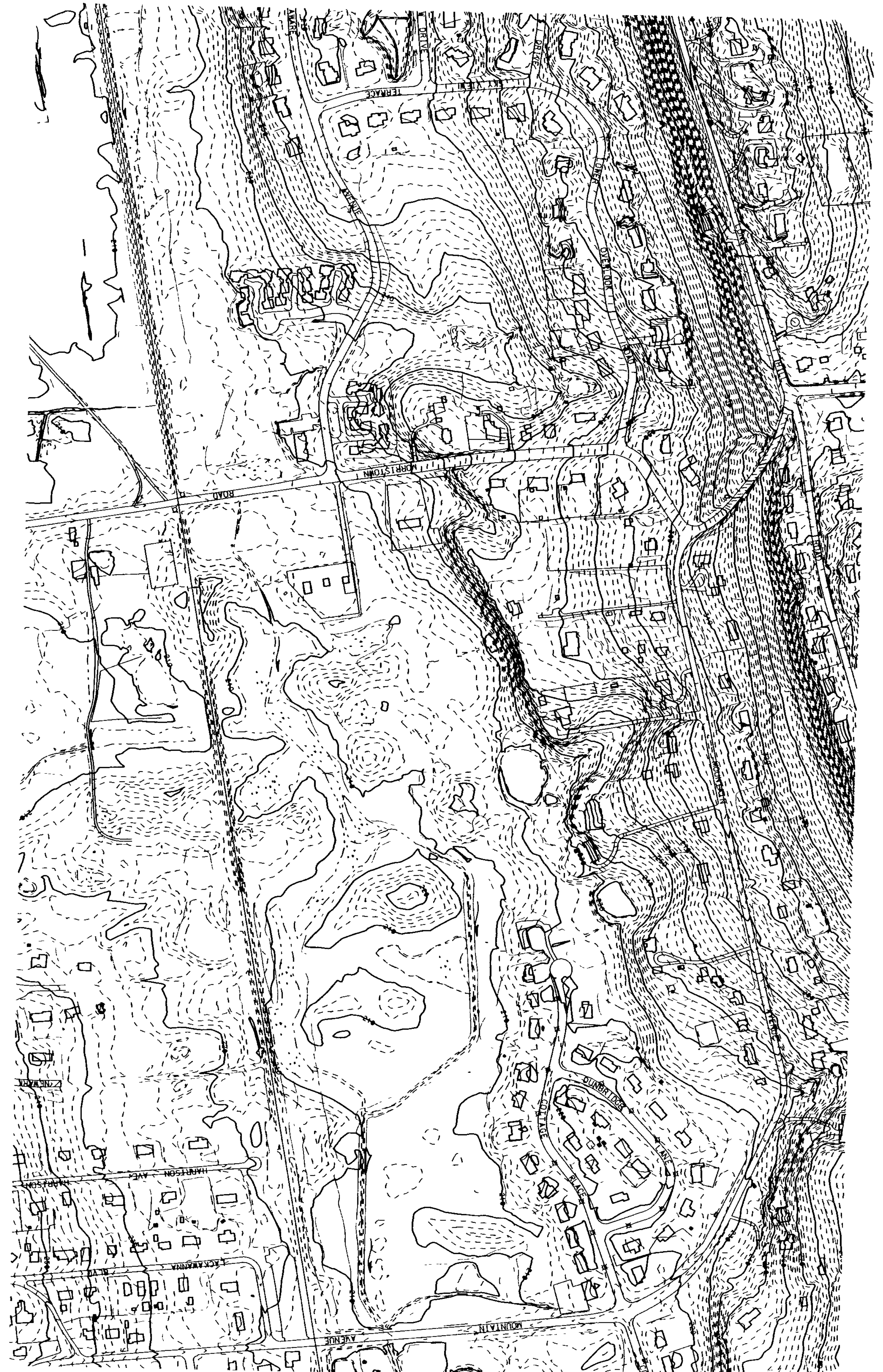
ADEKA ULTRA SEAL®

A-30 / P-201



A-30 - Hydrophilic liquid for sealing interlocks
A-30 will expand 3 X's by volume
Two Component Liquid - 15:1 ratio - 4 gallons net per set

P-201- Hydrophilic single component paste
P-201 will expand 2 X's by volume
3.17 gallons per pail - 10.7 oz. per cartridge



S.O No 24421
Subject: PASSAIC - SEEPAGE ANALYSIS
RR Embankment
Sheet No. 1a of 5
Drawing No
Computed by JD Checked By REC Date 4-3-03

Baker

Problem Statement:

Flood Floodwater from the Passaic River will pond within the area defined by the NJ Transit railroad, Morristown Road and Plainfield Avenue. See page 1b. The flood elevation is 214.

This impounded water will seep mainly through the RR embankment to the south side and collect in drainage ditches where it flows to a low area (Point A on page 1b).

A lesser amount of seepage will flow through the Morristown Road embankment and eventually through culverts around low areas near the town of Sterling.

Find: The quantity of seepage that flows through the embankments. This quantity will define the need for pump stations during flood events.

S.O. No. 244421
Subject: PASSAIC - FRICTION PILE CAPACITY
Gated Culverts
Sheet No 1 of 1
Drawing No.
Computed by JAD Checked By REC Date 4-8-03

Baker

Problem Statement

Find Pile Capacity at Gate Structures.

$q_u = 2.0$ TSF from pocket penetrometer

$c = 1.0$ TSF

$C_A = 950$ psf (NavFac DM-7, Figure 2 p. 7.2-196)

Pile diameter = 12"

$Q_{ult} = c(N_{cs})\pi R^2 + C_A\, 2\pi R Z$

$= 2000(9)\, 3.14(0.5)^2 + 950 \times 1.0 \times 3.14 \times Z$

$= 14130$ lbs $+ 2982\, Z$

$\frac{Q_{ult}}{3} = 4710 + 994\, Z$

let $Z = 30'$

$Q_{allow} = 4710 + 994(30) = 4710 + 29820$

$= 17.2$ TONS.

let $Z = 40'$

$Q_{allow} = \frac{4710 + 39760}{2000} = 22$ TON.

$\boxed{\text{Use 20T Pile @ 35'}}$

S.O No 24441
Subject PASSAIC ALLOWABLE BEARING PRESSURE
Sheet No. 1 of 1
Drawing No
Computed by JAD Checked By REC Date 4-8-03

Baker

Problem Statement:

Find Allowable Bearing Pressure for Gated Culverts at Borings B-1, B-G, B-3.

Soil at this locations is Silty Clay (CL-CH) with $q_u = 2.0$ TSF (based on pocket penetration readings)

Foundation Elev. = 208.

Presumptive bearing pressure for medium stiff to stiff clay = $\boxed{2.0 \text{ TSF}}$ (table 1, Page 7.2-1[illegible] of NavFac DM-7.2)

Bearing Capacity of Square Fdn.

$q_{ult} = cN_c \times (1 + .3\frac{B}{L}) + \gamma D$

$C = \frac{2.0}{2} = 1.0$ TSF

$N_c = 5.53$ (Ref = DM-7, Fig. 1, p. 7.2-131)

$B = 8'$, $L = 15'$

$\gamma = 120$ pcf.

$D = 4'$

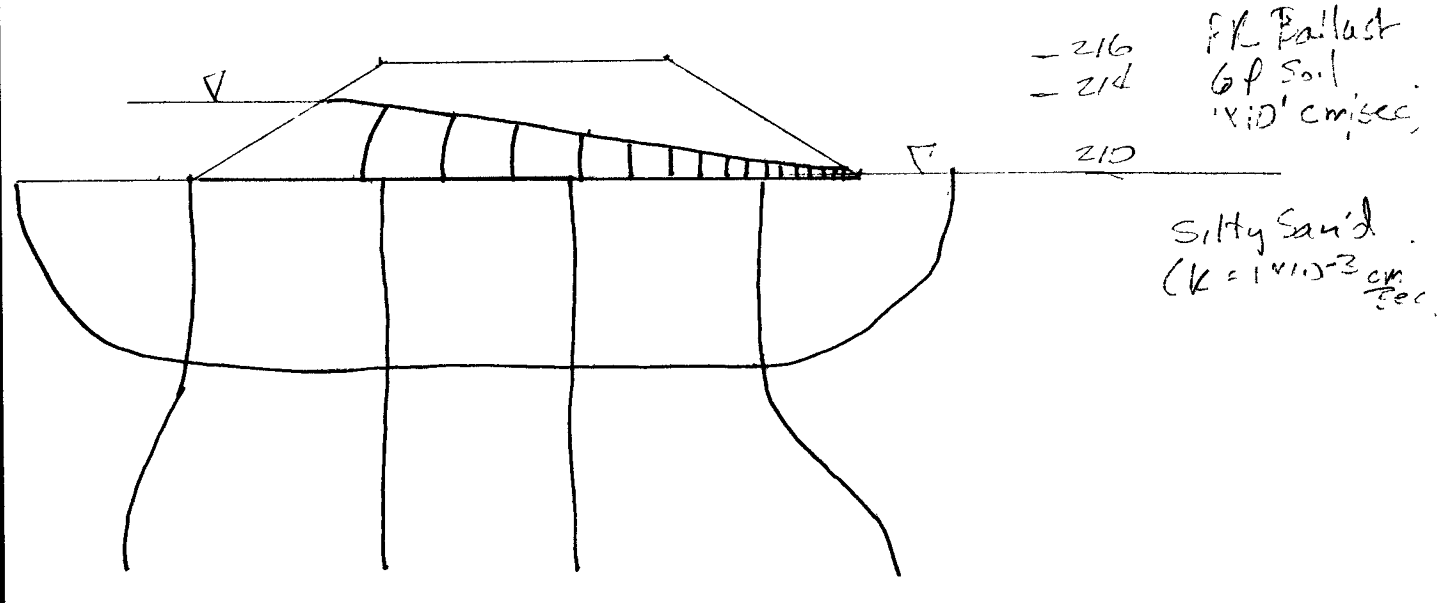
$q_{ult} = \underset{11060}{5.53 \times 2000} \times \underset{1.16}{(1 + .3\frac{8}{15})} + \underset{480}{120 \times 4} = 13,310$ psf

$\frac{q_{ult}}{FS} = \frac{13310}{3} = $ [illegible]

S.O No 24421
Subject: PASSAIC - SEEPAGE ANALYSIS
RR embankment
Sheet No 3 of 3
Drawing No
Computed by SAO Checked By REC Date 4-9-03

Baker

On the possibility that the entire RR embankment is RR ballast, See the Section Below.



Ballast: $nf = 1$ $nd = 18$ $h = 4ft$

$q = \frac{K\,nf}{nd} H$

$k = 10\ cm/sec \times \frac{1}{2.54} \times \frac{1}{12}$

$= 0.328\ FT/sec$

$q = 0.328 \times \frac{1}{18} \times 4 = 0.0729\ cfs/_{LF}$

$Q = 0.0729 \frac{cfs}{FT} \times 3400\ LF = \boxed{248\ CFS}$ Significant.

Silty Sand $= 0.22 \times \frac{0.4^*}{0.5} = 0.18\ cfs$ Insignificant.

* $nf = 2\ nd = 5$

S.O. No. 24421
Subject PASSAIC - SEEPAGE ANALYSIS
RR embankment
Sheet No 2 of 3
Drawing No.
Computed by SAO Checked By REC Date 4-7-03

Baker

$nf = 3$ $K = 1 \times 10^{-6}\ cm/sec$ (Silty Clay)

$nd = 6$ $H = 4\ FT$

$q = \frac{K\,nf}{nd} H$

$k = 1 \times 10^{-6} \frac{cm}{sec} \times \frac{1 in}{2.54\,cm} \cdot \frac{FT}{12\,in}$

$= 0.0328 \times 10^{-6} \frac{FT}{SEC}$

$= 3.28 \times 10^{-8}\ FT/sec$

$q_{(CFS/FT)} = 3.28 \times 10^{-8} \frac{FT}{SEC} \times \frac{3}{6} \times 4\ FT = 6.56 \times 10^{-8} \frac{CFS}{FT}$

$L = 3400\ LF$ (3100 LF RR from Morristown Rd to Mountain Ave and 300 LF of Morristown Rd. N. of RR Crossing*)

total $Q = 6.56 \times 10^{-8} \frac{CFS}{FT} \times 3400\ LF = 22.3 \times 10^{-5}\ CFS$

$= \boxed{2.23 \times 10^{-4}\ CFS}$ Negligible

If embankment is $k = 10^{-3}\ cm/sec$ (Medium Sandy or Silty Sand)

$Q = 2.23 \times 10^{-1}\ CFS = \boxed{0.22\ CFS}$ STILL Very Small

* Road is a larger Cross Section but use RR section for simplification - conservative

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S.O No 24421
Subject: PASSAIC - SEEPAGE ANALYSIS
RR embankment
Sheet No 1 of 3
Drawing No.
Computed by SAO Checked By REC Date 4-7-03

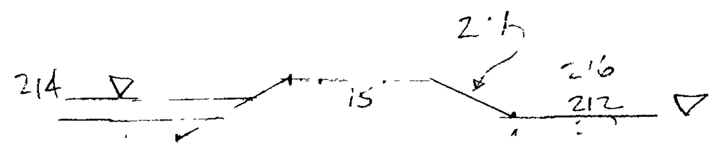
Baker

Cross Section through RR embankment

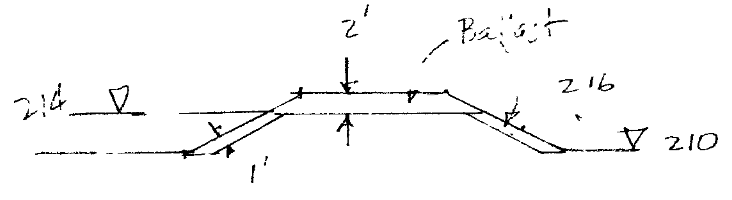
Source: Site Visits

Embankment Slopes are covered with ballast but the embankment interior is probably composed of earth

1" = 20'



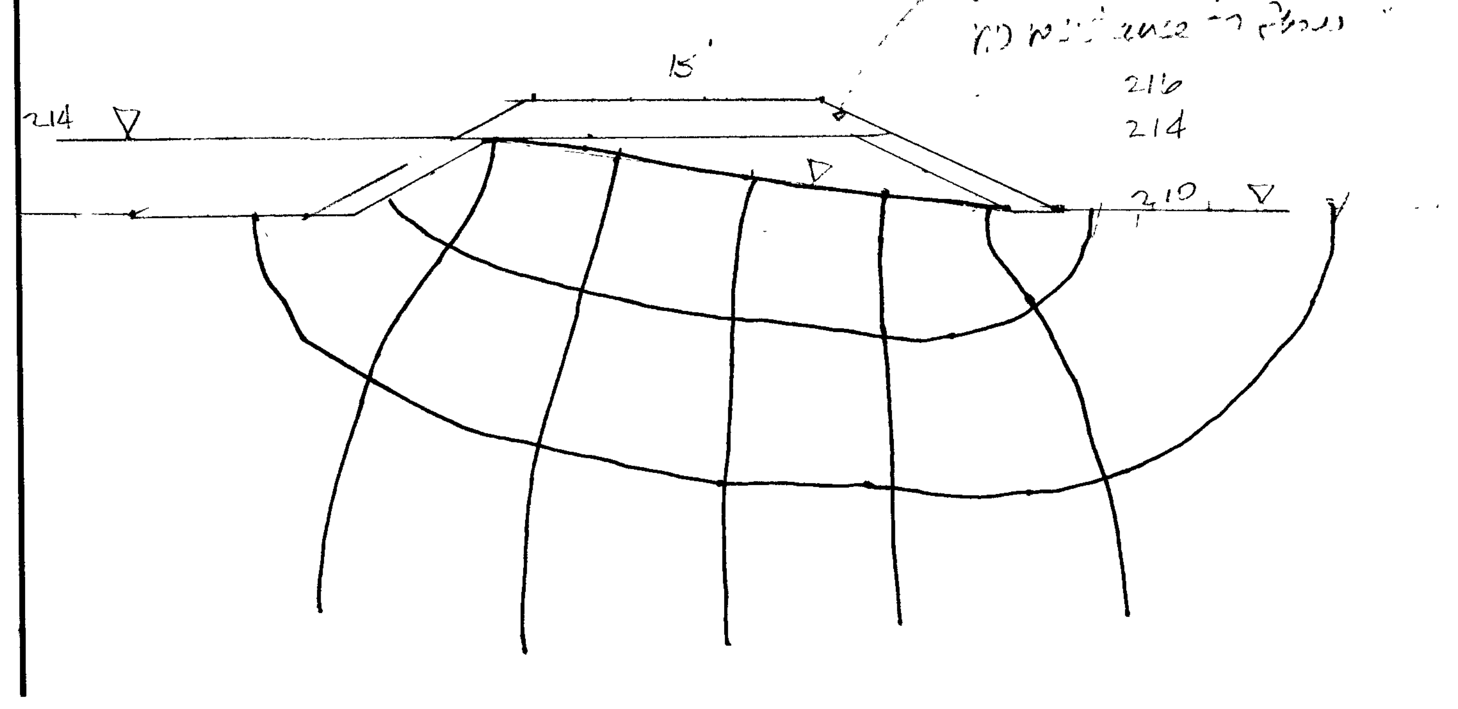
(1) Toe @ 212'



(2) Toe @ 210

Use
(1) Toe @ 210'

1" = 10'



UPPER PASSAIC RIVER
LONG HILL TOWNSHIP
FLOOD CONTROL PROJECT

HAZARDOUS, TOXIC WASTE and RADIOACTIVE WASTE SITE ASSESSMENT

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UPPER PASSAIC RIVER FLOOD CONTROL
LONG HILL TOWNSHIP
MORRIS COUNTY, NEW JERSEY

INTRODUCTION

HAZARDOUS, TOXIC WASTE and RADIOACTIVE WASTE SITE ASSESSMENT

The conducting of a Hazardous, Toxic and Radioactive Waste (HTRW) assessment is part of the overall site characterization conducted by the Corps of Engineers prior to any civil construction project. This required assessment is in accordance with ER 1165-2-132 entitled Hazardous, Toxic and Radioactive Waste Guidance for Civil Works, June 26, 1992. HTRW are defined as any "hazardous substance" regulated under Comprehensive, Environmental Response, Compensation, Liability Act (CERCLA), 42 U.S.C. 9601 et seq. Hazardous substances regulated under CERCLA include "hazardous wastes" under Section 3001 of the Resource Conservation and Recovery Act (RCRA), 42 U. S. C. 6921 et seq.

The Scope of Work (SOW) for the Upper Passaic Flood Control project called for eight (8) soil borings spread out along the proposed line of construction for the flood control structures. The borings were planned to be a combined sampling event. The collection of geotechnical and environmental samples were to be from the same soil boring, which represented a significant time saving in fieldwork. There were no plans for collecting sub-surface water samples and none were collected during fieldwork.

PROJECT DESCRIPTION

The New York District Planning Division-Environment Assessment Branch conducted the site investigation as part of the preliminary procedures for the Upper Passaic Flood Control Project. The objective was to identify any potential locations of HTRW impacted areas. In order to complete this objective the District contracted with Baker Engineering to provide sub-surface drilling and geo-technical analyses services, field sampling, and laboratory analytical services for the geotechnical samples and the Fort Monmouth Environmental Laboratory for the HTRW samples. District personnel were to be present to collect environmental samples and prepare them for shipment to the laboratory for analyses. The investigation included:

- Preparation of planning documents
- Field investigations:
    - Geotechnical samples.
    - HTRW samples.

The soil borings would be located along the proposed line of construction. The eight boring locations would be evenly spaced along this line and advance down to a maximum of twenty-five (25) feet below ground surface. Samples for geotechnical analyses would be pulled from the boring tool separate from the environmental samples. Environmental samples would be removed from the soil boring tool, visually described and then placed in clear eight (8) ounce jars. There will be preserving agents added to the samples, the preserving agent is methanol. Two environmental samples per soil boring would be collected. The reason for collecting environmental samples is to characterize sub-surface soil conditions prior to final plans being drawn up and construction. The HTRW samples were collected by an environmental specialist from the Corps of Engineers, New York District office. The geotechnical samples were collected by a field engineer from the contract A/E firm (Baker Engineering). See Table 1 for sample locations.

Being the area of proposed construction was the site of sporadic dumping of asbestos containing materials, three additional soil samples were collected from three separate areas for analysis on the level(s) of asbestos concentration.

BACKGROUND

A flood control project for the upper Passaic River area bordering the counties of Morris (north of the river) and Somerset (south of the river) has been authorized. The project is located within Long Hill Township Morris County. Within the township the project will pass through the communities of Gillette, Stirling and Millington. The project will affect approximately 2.0 miles of the Passaic River's northern side. There will be no activity on the river's south (Somerset County) side. The project's westerly end point is between Sussex and Passaic Streets south of Valley Road. The easterly end point is by Poplar Street, south of Valley Road in the ravine immediately west of the new Town Hall complex.

There will be no river channel modifications. Flood control measures will be construction of earthen levees and installation of vinyl sheet piling.

There are two potentially large environmental factors that could have a large impact on this project. The first factor is the presence of asbestos within the potential line of construction. Prior to this flood control project there was a federal Superfund site located in the township. The main source of contamination at this Superfund site was asbestos. Asbestos was used to make shingles and siding, any off spec product or waste was left on site or used as fill material in the lowlands adjacent the Passaic River flood plain in the communities of Gillette, Stirling and Millington. The source of this asbestos has been remediated and closed, but there exists small piles of shingles containing asbestos throughout the township. The small piles of asbestos encountered within the potential line of construction are primarily crumbled bits of asbestos containing shingles. The asbestos is in solid form and not prone to being eroded or washed away by flowing water because the places it has been dumped in are areas away from the river and not in any high water channel.

The main concern with this asbestos along the potential line of construction is possible exposure of construction workers to air-borne asbestos. Considering the construction methods proposed for this flood protection, the small quantities of asbestos found, leads us to conclude this material should not be a major factor during the construction of this flood protection project. There are managerial procedures and protocols that can be implemented to reduce the potential of exposure to construction workers. A letter written by Mr. C. E. Defendorf, New Jersey Department of Environmental Protection, Dam Safety Section, dated April 24, 2003 (Attachment A) concurs with the District's assessment of the low risk potential from the non-friable asbestos presently along the proposed line of construction. Table 2 shows asbestos content in the samples to be below action levels.

The second potential problem is the presence of arsenic in a large concentration at one location (B-5). Normal arsenic-in-soil concentrations for this area of New Jersey is single digit parts per million. One sub-surface sample had a level of 78 parts per million (Table 3) , the other nine samples had single digits numbers. This sample is located on the edge of a paved parking lot to a commercial establishment adjacent to the right-of-way for overhead high tension power lines. The maximum allowable arsenic concentration in soil is 20 parts per million per the New Jersey Department of Environmental Protection Non-Residential Direct Contact Clean-up Criteria (NRDCCC). Upon discussions with the state and considering the location of the samples and the desired end use of the area it was concluded the high number would not be an impediment to construction when that time comes. There are engineering and supervisory controls that can be employed to reduce the potential of exposure.

Testing results for semivolatile organics, pesticides/PCB's, and volatile organics are shown in Tables 4, 5, and 6.

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TABLES

Table 1
HTRW Soil Characterization:
Upper Passaic Flood Control
Long Hill Township, Morris County, New Jersey
BORINGS DATA SHEET

Boring Number		Depth	Date	Time	Sample Type
B-1		20' bgs	10/29/2002	1500	Soil
B-2		15' bgs	10/30/2002	1615	Soil
B-3		15' bgs	10/30/2002	1445	Soil
B-4		20' bgs	10/30/2003	1330	Soil
B-5		15' bgs	10/30/2002	1230	Soil
B-6		15' bgs	10/30/2002	930	Soil
B-7		10' bgs	10/29/2002	1615	Soil
B-8		15' bgs	10/29/2002	1215	Soil
Trip Blank (TB)			10/30/2029		Methanol

bgs = below ground surface
Methanol - preservative agent soil samples were placed in

Table 2
HTRW Soil Characterization:
Upper Passaic Flood Control
Long Hill Township, Morris County, New Jersey
ASBESTOS DATA SHEET

Sample No.	Matrix	% Asbestos
UP-ACM2	Soil	<1.0% Chrysotile
UP-ACM3	Soil	<1.0% Chrysotile
UP-ACM4	Soil	>1.0% Chrysotile

Action level for asbestos containing soils is one percent or greater

Table 3
HTRW Soil Characterization
Upper Passaic Flood Control
Long Hill Township, Morris County, New Jersey
METALS DATA SHEET

ELEMENT	RESULT	NRDCSCC	RDCSCC	BORING No.
Arsenic	78.2 ppm	20.0 ppm	20.0 ppm	B - 5
Barium	1440 ppm	47,000 ppm	700 ppm	B - 5
Cadmium	ND			
Chromium	ND			
Lead	ND			
Mercury	ND			
Selenium	ND			
Silver	ND			

I. Non-Detect---ND
2. Parts Per Million---ppm
3 Non-Residential Direct Contact Soil Claeanup Criteria---NRDCSCC
4 Residential Direct Contact Soil Cleanup Criteria---RDCSCC

Boring - 5 Arsenic results are looked upon as unusual for the area and in comparison to the other samples, however it is judged as a non-issue considering the location of the sample and the planned end-use of that area.

Boring - 5 Barium results are above the RDCSCC level, however when compared the sample results are substantially below the NRDCSCC. Considering the planned nd use of the area this result is viewed as a non-issue.

Table 4
HTRW Soil Characterization
Upper Passaic Flood Control
Long Hill Township, Morris County, New Jersey
SEMIVOLATILE ORGANICS DATA SHEET

Compound	Concentration Units: (ug/L or ug/KG) UG/KG	Q	NRDCSCC	RDCSCC
Acenaphthene	110	U		
2,4-Dinitrophenol	290	U		
Dibenzofuran	130	U		
4-Nitrophenol	160	U		
2,4-Dinitrotoluene	130	U		
Diethylphthalate	150	U		
Fluorene	130	U		
4-Chlorophenyl-phenylether	130	U		
4-Nitroaniline	140	U		
4,6-Dinitro-2 methylphenol	540	U		
n-Nitrosodiphenylamine	130	U		
Azobenzene	150	U		
4-Bromophenyl-phenylether	130	U		
Hexachlorobenzene	120	U		
Pentachlorophenol	390	U		
Phenathrene	120	U		
Anthracene	120	U		
Di-n-butylphthalate	180	U		
Fluoanthene	120	U		
Benzidine	730	U		
Pyrene	120	U		
Butylbenzyphthalate	150	U		
Benzo[a]anthracene	120	U		
3,3'-Dichlorobenzidine	200	U		
Chrysene	110	U		
bis(2-Ethylhexyl)phtalate	170	U		
Di-n-octylphthalate	170	U		
Benzo[b]flouranthene	120	U		

Table 4
HTRW Soil Characterization:
Upper Passaic Flood Control
Long Hill Township, Morris County, New Jersey
SEMIVOLATILE ORGANICS DATA SHEET

Benzo[k]flouranthene	110	U		
Benzo[a]pyrene	110	U		
Indeno [1,2,3-cd]pyrene	110	U		
Dibenz[a,h]anthracene	75	U		
Benzo[g,h,i]perylene	110	U		
Pyridine	230	U		
N-nitroso-dimethylamine	170	U		
Aniline	180	U		
Phenol	150	U		
bis(2-Chloroethyl)ether	150	U		
2-Chlorophenol	150	U		
1,3-Dichlorobenzene	140	U		
1,4-Dichlorobenzene	150	U		
Benzyl alcohol	150	U		
1,2-Dichlorobenzene	130	U		
2-Methylphenol	140	U		
bis(2-chloroisopropyl)ether	160	U		
4-methylphenol	170	U		
n-Nitroso-di-n-propylamine	150	U		
Hexachloroethane	160	U		
Nitrobenzene	150	U		
Isophorone	140	U		
2-Nitrophenol	140	U		
2,4-Dimethylphenol	240	U		
bis(2-Chloroethoxy)methane	160	U		
2,4-Dichlorophenol	170	U		
Benzoic Acid	67	U		
1,2,4-Trichlorobenzene	140	U		
Naphthalene	140	U		
4-Chloroaniline	180	U		
Hexachlorobutadiene	94	U		

Table 4
HTRW Soil Characterization:
Upper Passaic Flood Control
Long Hill Township, Morris County, New Jersey
SEMIVOLATILE ORGANICS DATA SHEET

4-Chloro-3-methylphenol	170	U		
2-Methylnaphthalene	150	U		
Hexachlorocyclopentadiene	280	U		
2,4,6-Trichlorophenol	150	U		
2,4,5-Trichlorophenol	130	U		
2-Chloronaphthalene	140	U		
2-Nitroaniline	150	U		
Dimethylphthalate	170	U		
Acenaphthylene	130	U		
2,6-Dinitrotoluene	150	U		
3-Nitroaniline	150	U		

NRDCSCC-Non-Residential Direct Contact Cleanup Criteria (NJDEP)

RDSCC-Residential Contact Soil Cleanup Criteria(NJDEP)

J-Compound detected but value is estimated

B-Compound found in blank

U-Undetect

There were ten (10) unknown SVOA compounds detected in the analyses All ten had estimated values, no precise result was possible due to the unknown qualities of the compounds.

The cumulative total of the unknowns is 23.7 ppm, this is substantially below the NJDEP threshold for SVOAs

One SVOA (Di-n-butylphthalate) was consistenly found in the samples with an estimated value and found in lab blank as well. This compound may have been introduced into the analyses from a laboratory source.-

Table 5
HTRW Soil Characterization:
Upper Passaic Flood Control
Long Hill Township, Morris County, New Jersey
Pesticides/PCB's DATA SHEET

Name	Result (mg/kg)	NRDCSCC	RDCSCC
alpha-BHC	ND		
beta-BHC	ND		
gamma-BHC	ND		
delta-BHC	ND		
Heptachlor	ND		
Aldrin	ND		
Heptachlor Epoxide	ND		
Endosulfan I	ND		
4,4'-DDE	ND		
Dieldrin	ND		
Endrin	ND		
Endosulfan II	ND		
4,4'-DDD	ND		
Endosulfan-Aldehyde	ND		
4,4'-DDT	ND		
Endosulfan-Sulfate	ND		
gamma-Chlordane	ND		
alpha-Chlordane	ND		
Methoxychlor	ND		
Toxaphene	ND		
Arochlor 1016	ND		
Arochlor 1221	ND		
Arochlor 1232	ND		
Arochlor 1242	ND		
Arochlor 1248	ND		
Arochlor 1254	ND		
Arochlor 1260	ND		

ND = Not Detected
MDL = Method Detection Limit
NLE = No Limit Established
NRDCSCC = Non Residential Direct Contact Soil Cleanup Criteria (NJDEP)
RDCSCC = Residential Direct Contact Cleanup Criteria (NJDEP)

There were no detections for the above listed compounds

Table 6
HTRW Soil Characterization:
Upper Passaic Flood Control
Long Hill Township, Morris County, New Jersey
VOLITILE ORGANICS DATA SHEET

Compound	Concentration Units: (ug/L or ug/Kg) UG/KG	Q	NRDCSCC	RDCSCC
Acrolein	610	U		
Acrylonitrile	610	U		
tert-Butyl alcohol	1100	U		
Methyl-tert-Butyl ether	260	U		
Di-isopropyl ether	170	U		
Dichlorodifluoromethane	350	U		
Chloromethane	87	U		
Vinyl Chloride	260	U		
Bromomethane	170	U		
Chloroethane	260	U		
Trichlorofluoromethane	170	U		
1,1-Dichloroethene	87	U		
Acetone	390	B		
Carbon Disulfide	87	U		
Methylene Chloride	170	U		
trans-1,2-Dichloroethene	170	U		
1,1-Dichloroethane	87	U		
Vinyl Acetate	260	U		
2-Butanone	260	U		
cis-1,2-Dichloroethene	87	U		
Chloroform	87	U		
1,1,1-Trichloroethane	87	U		
Carbon Tetrachloride	170	U		
Benzene	87	U		
1,2-Dichloroethane	170	U		
Trichloroethene	87	U		
1,2-Dichloropropane	87	U		

NRDCSCC-Non-Residential Direct Contact Cleanup Criteria (NJDEP)
RDSCC-Residential Contact Soil Cleanup Criteria (NJDEP)
J-Compound detected below detection limit
B-Compound found in blank
U-Undetect

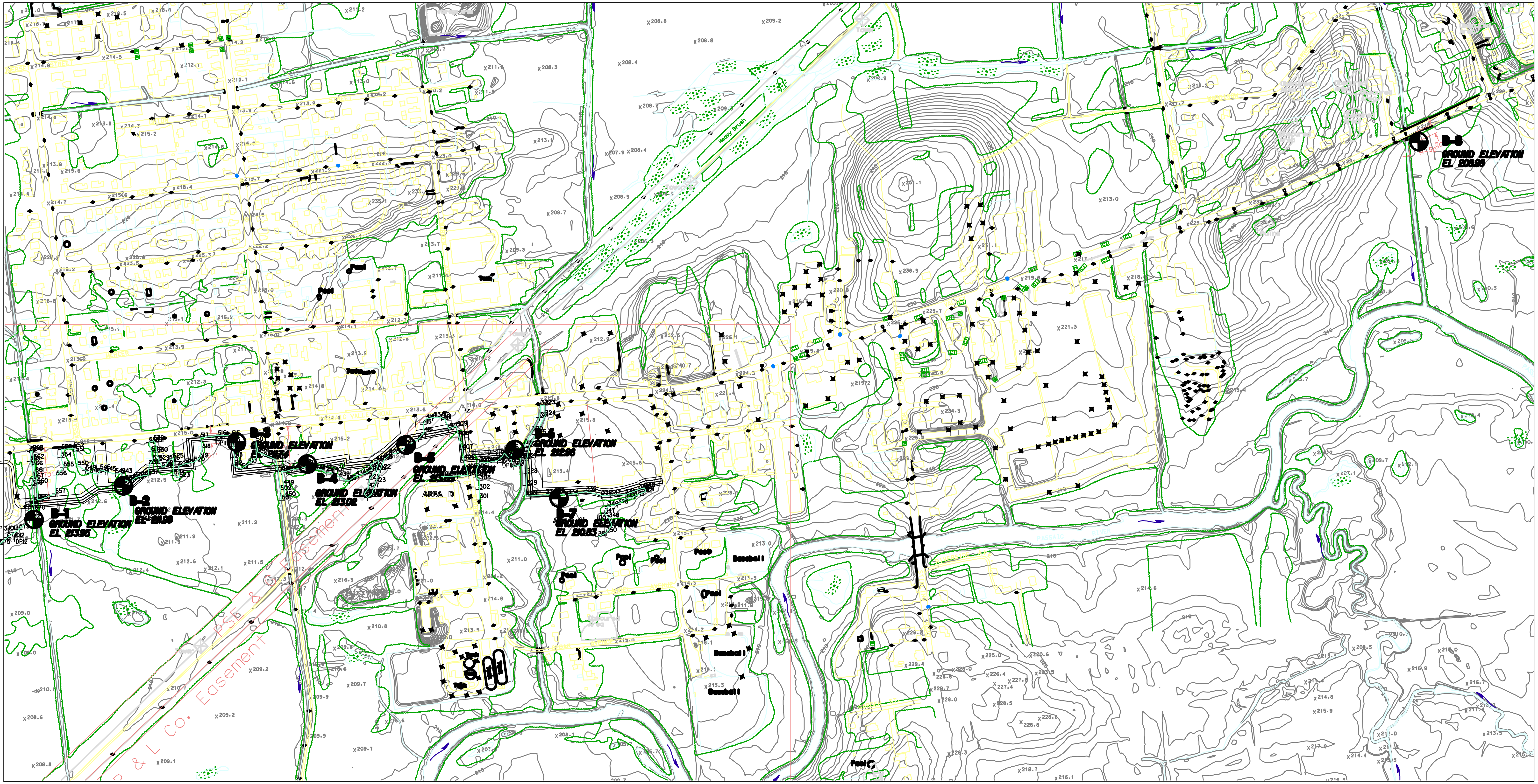
Table 6
HTRW Soil Characterization:
Upper Passaic Flood Control
Long Hill Township, Morris County, New Jersey
VOLITILE ORGANICS DATA SHEET

Bromodichloromethane	87	U		
2-Chloroethyl vinyl ether	170	U		
cis-1,3-Dichloropropene	87	U		
4-Methyl-2-Pentanone	170	U		
Toluene	21	J		
trans-1,3-Dichloropropene	170	U		
1,1,2-Trichloroethane	170	U		
Tetrachloroethene	87	U		
2-Hexanone	170	U		
Dibromochloromethane	170	U		
Chlorobenzene	87	U		
Ethlybenzene	170	U		
m+p-Xylenes	260	U		
o-Xylene	170	U		
Styrene	170	U		
Bromoform	170	U		
1,1,2,2-Tetrachloroethane	170	U		
1,3-Dichlorobenzene	260	U		
1,4-Dichlorobenzene	260	U		
1,2-Dichlorobenzene	260	U		

NRDCSCC-Non-Residential Direct Contact Cleanup Criteria (NJDEP)
RDSCC-Residential Contact Soil Cleanup Criteria (NJDEP)
J-Compound detected below detection limit
B-Compound found in blank
U-Undetect

Acetone and Toluene were consistently found in all samples at either an estimated value or in the Blank. Both instances are not viewed as problems. Their minute presence can be attributed to lab procedures.
No other compounds were found above threshold levels.

FIGURES



LEGEND:

B-1	BORING LOCATION
	LIMIT OF CONSTRUCTION EASEMENT
	LIMIT OF PERMANENT EASEMENT
	FLOOD WALL
	CONTRACTORS YARD TO BE DETERMINED

UPPER PASSAIC RIVER FLOOD CONTROL

Long Hill Township

HTRW BORING SITES

ATTACHMENT A

State of New Jersey
Department of Environmental Protection

James E. McGreevey
Governor

Bradley M. Campbell
Commissioner

APR 24 2003

MEMORANDUM

To: File

From: C. E. Defendorf, P.E.

Subject: Existing Solid Waste Issues – Long Hill Flood Control

Within Long Hill Township, the Corps of Engineers and the State of New Jersey Department of Environmental Protection, the non-federal sponsor for the project, are proposing approximately 4000 ft of flood works consisting of sheet pile and low flood levees designed to provide substantial protection from Passaic River flooding.

In response to my inquiry, Nelson Hausman of Solid Waste Management has concurred with our conclusion that the results of analysis of samples containing non-friable asbestos constitutes incidental debree. While requiring care during construction to insure that it remains damp and not become air-born, the waste may be left in place and need not be removed from the site. This conclusion is based on the use of construction methods that constitutes very limited site disturbance during the installation of the sheet pile wall or the construction of the low earthen levee that will encapsulate the incidental debree. The ultimate use of the disturbance area will be deed restricted limited access for maintenance open space.

C. E. Defendorf